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INSTRUMENTS

INDUSTRIAL — SCIENTIFIC

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Devoted to Measurement and Control Problems

Vol. 2. No. 10 Pittsburgh, Pa. October, 1929

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DR. WALTER BLOCK

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E. OWER

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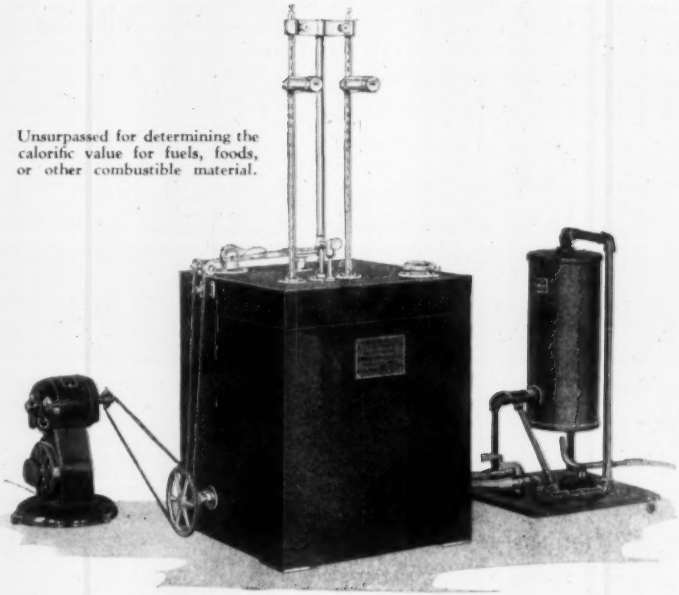

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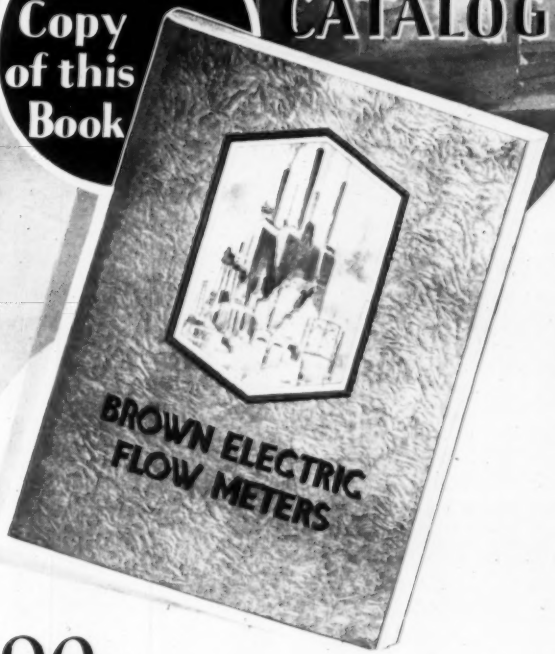

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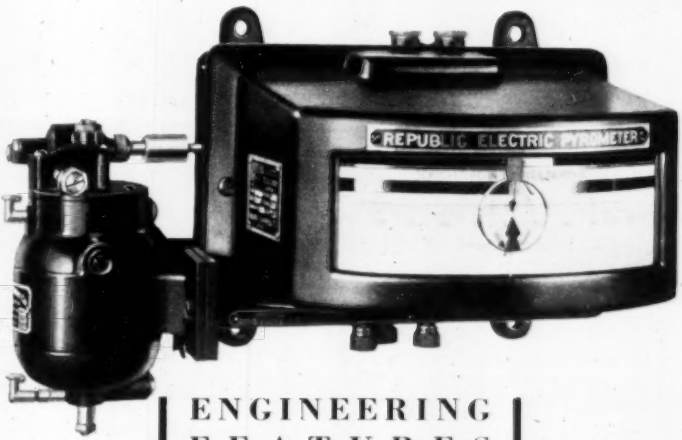

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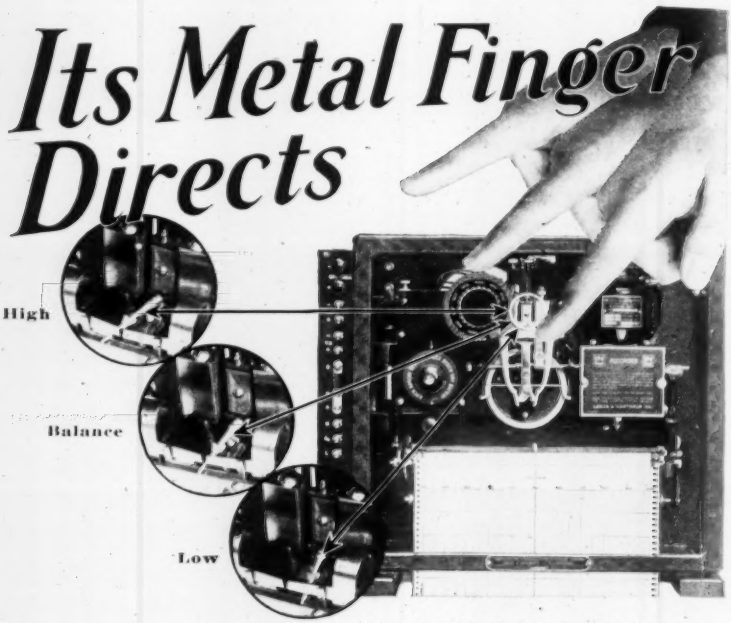

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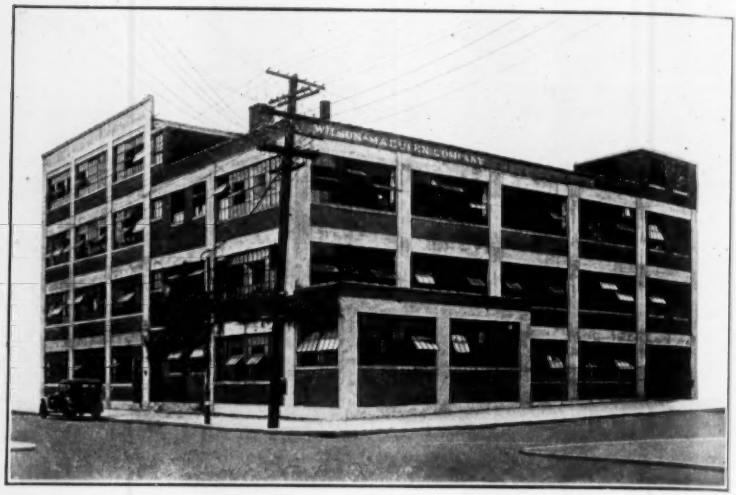

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INDUSTRIAL — SCIENTIFIC

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Vol. 2, No. 10 OCTOBER, 1929 Pittsburgh, Pa.

To Our Readers

NEXT to possessing information on any subject, the ideal condition is to know where to find it. The information on almost any subject is so great as to lie beyond the knowledge of an individual. The problem usually is to know where to find what is wanted—the demand for information of all kinds has grown so rapidly that one is often at his wit's end to know where to look.

The need for an agency to disseminate information pertaining to instruments and devices for measurement, inspection and control, is evidenced by the increase in this phase of the work performed by INSTRUMENTS. During its first year (1928) the Information Section of INSTRUMENTS received on an average of 30 requests per month for sources of supply, the first six months of this year this number was almost doubled, while the average number of questions received during the past three months was over 90 per month.

INSTRUMENTS continually strives to bring together all information pertaining to measurements and instruments—the articles in a large number of publications are currently abstracted, the new literature published by manufacturers on instruments, meters, etc., is listed monthly, descriptions of new measuring and control devices are covered as soon after their development as the information can be obtained. Further, a list of the books at present available on this subject has been prepared in printed form and is available for distribution. Our catalogue files contain the most complete sets of manufacturers' literature. An instrument index on the sources of supply of instruments of all kinds is in the course of preparation. New books on this subject are reviewed and in some cases translations will be made.

If we can assist you, write us.

———— :: ————

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The Instrument Exhibits at the National Metal Exposition

INSTRUMENTS are daily becoming a more important factor in all industries. That this fact is being more fully appreciated is apparent from the interest aroused by the exhibits of instruments at the National Metal Exposition. A number of new instruments and devices for measurement and control were exhibited. The instruments displayed are mentioned below as no doubt many of the readers did not have the opportunity of attending the exposition and many who did, could not visit all of the splendid exhibits for the lack of time.

The American Gas Furnace Company had a new gas flow meter and temperature controllers in operation on gas heating furnaces.

The Automatic Temperature Control Company, Inc. showed under operating conditions: two balancing three-position controllers with anticipating features; a three-position single motor controller and a two-position single motor controller. A three-position motion controller operating an 8" air and 1" oil valves was set up to operate from push button switches. An electric heater controller designed to save power as compared with rheostat operation of small electric furnaces was also shown.

The exhibit of the Bristol Company was an operating exhibit and featured the following: a pyrometer controller, indicating and recording pyrometers, a new line of automatic temperature controllers, including motor valves for gas, oil, air and steam of the floating type. Their latest development, a hot blast temperature controller was included.

The following very complete line of instruments was displayed in the booth of the Brown Instrument Company: indicating, signaling, controlling and recording pyrometers; indicating and recording flow meters; recording and controlling thermometers; indicating and recording CO_2 meters; recording and controlling pressure gauges; automatic control valves and thermocouples and protecting tubes.

An apparatus for the determination of CO, shown for the first time, was on display in the booth of the Chemical Rubber Company, as well as laboratory equipment.

The Coats Machine Tool Company, Inc. exhibited: the complete line of Krupp Mikrotast gauges for internal and external gauging; light contact Mikrotasts for gauging very fine wire; Mikrotast grinding gauges for use on cylindrical grinders while in operation; Elasticometer spring testing machines for tension and compression tests; Prestometer micrometer fluid gauge; hand tachometers and speed recording indicators.

X-ray negatives and photographs of castings showing internal flaws detected by the use of X-rays in the examination of these materials were shown by the Eastman Kodak Company, Kelley-Koett Manufacturing Company and Victor X-Ray Corporation.

Volumetric carbon determination apparatus for making determinations in 3½ minutes, a new vest pocket pyrometer and a quick acting laboratory balance were exhibited by Birger Egeberg.

R. Y. Ferner Company showed new models of micro-indicator tubes and stands for high precision measurements in inspection work; a universal measuring machine, designed for internal as well as external measurements, including all measurements of screw threads; and high precision measuring microscopes.

A line of graduating and snap action thermostatic gas valves for water temperature control was on display in the booth of the Flannery Manufacturing Company.

Portable and wall type pyrometers, resistance thermometers and special electrical, mechanical, magnetic and pyrometric instruments were shown by the Illinois Testing Laboratories, Inc.

The Leeds & Northrup Company showed their potentiometer pyrometers in the form of indicating, recording and controlling instruments, also Hump and Homo furnaces. One of the features of this exhibit, which attracted a great deal of attention was the demonstration board whereon was shown visually the fact that the potentiometer pyrometer was unaffected by throwing in series in the circuit various resistances, the leads could be changed from 10 to 100 and 500 feet without throwing the needle off at all.

In the booth of E. Leitz, Inc. the Leitz micro-metallograph was on display. This is a laboratory instrument embodying several recent developments. The metallurscope, a portable metallographic instrument of simplified construction, was also shown, as well as the Guthrie-Leitz grinding and polishing machine, and smaller size microscopes and numerous accessories.

A 100,000 pound 3-screw autographic and automatic universal testing machine with quick change eight-speed reverse gear box drive was in operation in the Tinius Olsen Testing Machine Company booth. Other testing machines exhibited by this company were: combined impact tension and cantilever type impact tester; Haight alternate stress testing machine for determining fatigue limit in tension and compression; direct motor driven production type Brinell hardness tester; Herbert direct motor driven production type "Cloudburst" hardness tester; a hardness tester for rubber compounds; a motor driven production type ductility testing machine for determining the drawing quality of sheet metal; proving and verifying rings; various types of strain gauges; Olsen-Lundgren dynamic balancing machine operating on centrifugal

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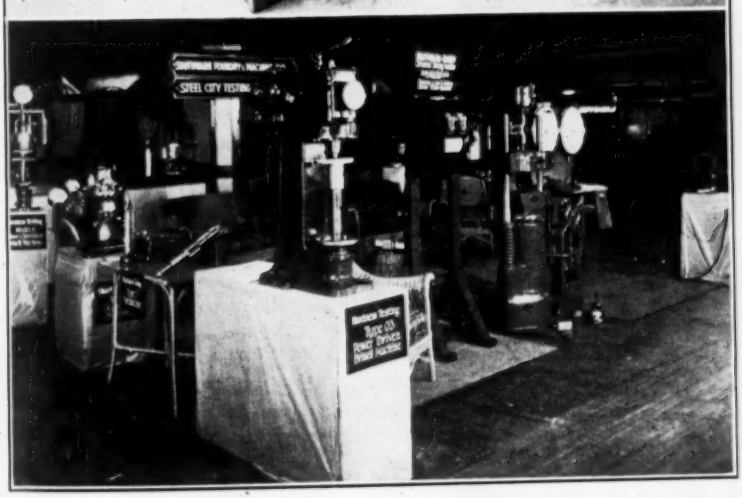
STEEL CITY TESTING

high tension spark principle and an Olsen-Lundgren automatic weighing static balancing machine for statically balancing rotating parts.

A Ranarex indicating and recording CO_2 meter was exhibited in the booth of the Permutit Company.

The Pittsburgh Instrument & Machine Company exhibited precision, production, power-driven and hand operated Brinell hardness testing machines, a sheet metal tester, a metallographic grinder, a Brinell microscope, a Brinell depth indicator, and proving rings.

A complete exhibit of the new control pyrometer on a small electric furnace as well as with an automatic valve was shown by the Republic Flow Meter Company. The display also included flow meters, gas meters and a CO_2 meter.

The Riehle Brothers Testing Machine Company displayed a Vickers hardness tester, Brinell machine, calibrating rings and a mirror extensometer reading to 1/100,000 of an inch.

The latest model dilatometer was exhibited by Stanley P. Rockwell Company. A new type of automatic control valve containing features of program control and multiple stage adjustment was shown in the booth of Ryan, Scully and Company.

George Scherr Company, Inc. had Carl Zeiss precision measuring machines and instruments on show. In the booth of the Shore Instrument and Mfg. Company the following was on display: various types of scleroscopes, rubber testing instruments, the Monotron and the Pyroscope.

The 60,000 pound Southwark-Emery universal testing machine attracted considerable attention. Specimens were tested almost continuously in tension and compression. The machine has a hydraulic drive and the Emery weighing system with loads indicated on large dials, the new electric multiple range stress-strain recorder was shown in operation on this machine. In addition there was shown a 40,000 pound hydraulic testing machine for field tests of welded joints; McCollum-Peters electric telemeter; Whittemore strain gauge and the Huggenberger tensometer. The Steel City Testing Laboratory occupying the same booth exhibited: hand and power operated Brinell machines, a hardness testing hammer, a sheet metal tester and proving rings.

A Moore fatigue testing machine was shown in the booth of the Thompson Grinder Company.

Automatic weighing, counting and checking scales were displayed by the Toledo Scale Company. The Toledo Precision Devices, Inc., a subsidiary of the Toledo Scale Company exhibited a special Autogage for insuring the uniform compression of piston rings and for testing valve springs.

The Harold E. Trent Company exhibited the operation of their temperature controls for heat treating, pit type, pot type and oil quench type furnaces.

In addition to indicating, recording and controlling pyrometers; electric resistance thermometers and Rockwell hardness testers, the Wilson Maeulen Company exhibited a new potentiometric recorder with a 12 inch strip chart.

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CHAPTER I

The Historical Development of the Measuring Science and the Systems of Length and Weight

by
DR. FRITZ PLATO
Director a. d. Reichsanstalt fuer Mass und Gewicht

with 109 Figures in the Text.
1928

I. INTRODUCTION

MEASURING and weighing not only form the most necessary prerequisite of every exchange of goods, from the simplest barter of the savage tribes to the world wide commerce of the princely merchant, but also make up the necessary basis of all scientific research and technical knowledge. Physics and chemistry owe their immense advances in the study of the processes of nature in no small measure to the continual improvement of measurements and methods of measurement, and the highly developed engineering of the present, in fact, would be inconceivable without the finest measuring-means and measurements. From earliest times, therefore, the greatest attention was given to the development of measurements and the measuring science.

Measuring in the most general sense of the word denotes the determination of quantity. The measurement of a certain unit is carried out by comparison with another unit. By weighing we understand the determination of mass sizes, it therefore falls within the more general conception of measurement.

The quantity, with which the comparison is made, is designated as the measure. It is called the measuring unit, if the quantity measured is brought into numerical relation to the measure and expressed as a multiple or fractional part of it. Principal units are such units for the conception of which other units need not be used. Auxiliary or derived units only have value in reference to the principal units. Sub-units are used, if with the expression of the value relation of a quantity to a principal—or auxiliary unit numbers are obtained which are too large or too small. The meter, for example, is a principal unit, as its explanation requires no other units, it stands by itself. Square meter and cubic meter are auxiliary or derived units; they only have sense or value due to their relation to the meter. Kilometer, millimeter, micron are sub-units; of themselves they are superfluous, as each length can be ex-

EDITOR'S NOTE: INSTRUMENTS has secured the complete rights for publication in the English language of the latest book on measurements by Dr. Block. The English translation will be published serially in INSTRUMENTS, the first installment appearing in the September issue.

pressed in meters, but they prove very serviceable with the numerical representation of very large or very small lengths.

Every quantity can be compared and measured only with a quantity of like kind, for example lengths, masses, forces, resistances only with lengths, masses, forces, resistances respectively. For each quantity, therefore, a specific unit should be determined. Actually, though, the vast number of special units can be reduced to three basic units. All physical phenomena consist, in the last analysis, of motions. Each motion, however, presupposes the existence of three quantities which must be considered as basic: a mass which moves, a space in which the movement occurs, and a time within which the movement takes place: For this reason, the science of physics requires only three fundamental units, one for the mass, one for the space, and one for the time. In chemistry the same applies. In the technical sciences often only the two units of mass and space suffice, of course only in so far as they are not pure and applied physics and chemistry. In commerce, time is of importance, in most cases only for the determination of wages but hardly serves as a measuring unit. One could go still a step further and be satisfied with one fundamental unit, i.e. that for space because units for space and mass are, as a rule, not independent of each other since the unit of mass is related in many measuring systems to the mass of a space filled with a certain material, generally water of given density. Accordingly, only the unit of space would be a fundamental unit, and the unit of mass a derived unit. It is possible however, that the mass unit be the fundamental one and the space unit the derived one. Also, the time unit can be made the starting point for all other quantities.[1]

The number of fundamental units is, therefore, strictly limited, not more than three. Nevertheless, the number of principal units is without limit because each quantity can be used as a unit for any other quantity of the same kind provided only that two people or a community agree to recognize it as unit. Therefrom spring the limitless abundance of units and of measuring systems based on them in ancient times where almost every family formed an independent group. Only when such small communities began to communicate with others or joined larger communities was the necessity for common units and measuring systems felt and became the more urgent as international trade increased. Aside from a few oriental measuring systems of more or less local importance only two systems are, at present, in use: the Metric and the English system. The first named, however, is making considerable strides to replace the latter entirely, and to gain the sole recognition of the whole world.

In the choice of units the quantities given by nature thrust themselves forward. And indeed, almost all units were originally natural units, and every time a new measuring system was created or introduced it was agreed from the beginning that the principal unit be taken from nature. The advantage of natural quantities is said to consist in that they can be derived, even though all their embodiments should all be lost at the same time, solely by the nature of their con-

[1]For all these questions see the treatise by Wallot in Handbuch der Physik, vol. II, Berlin, 1926.

ception from the original natural quantity. It was, however, overlooked even up to most recent times that all things in nature are subject to continuous changes, except mass and matter. Even the earth changes its shape and form and is doomed, like all celestial bodies, to destruction. Further, it was not taken into account that natural quantities could not be used directly for measuring purposes. First, embodiments or replicas must be made in order to make them serviceable for practical use. Since all measurements are subject to errors replicas cannot agree, neither with the original quantities nor among themselves, with sufficient accuracy that they could be considered to be absolutely identical. One of them had, therefore to be set over the others and made the only original unit to which all other units were to be related.

The original units were in most cases, kept in the principal temple of the State God and declared to be a holy unit. By this fact though the natural unit lost its significance as a unit, and its place was taken by its replica, the prototype. Finally, the natural quantities were neglected altogether even when the latter was not destroyed, and the connection between natural quantity and the prototype which at first was considered only as a replica remained mainly in its designation; the natural unit became a conventional unit. The most recent measuring system, namely the metric, has passed through exactly the same process of development.

Which natural quantities were preferred as units is shown by the designations which almost without exception refer to the parts of the human body or perhaps to occupations, or also to things belonging to human surroundings. Especially are the designations of units of length derived from parts of the body or from lengths which can be grasped or measured by them. In all peoples are found names like ell (length of the lower arm from elbow to the tip of the middle finger), hand, span (distance between the tips of stretched thumb and little finger), fist, thumb, thumbs breadth, foot, pace (distance of one step in walking), etc. Some peoples, in addition to these, used the width of a barley corn, breadth of a horse hair or mule hair and similar, as they are still used today in the Orient and by the Arabs and Persians. For larger lengths, especially for distance, among others, the following were used: stone's throw, a day's journey, 1000 paces. Size and designation of units for areas, in so far as they were not formed simply by the squares of the length units, were derived, preferably from agricultural measurements, from the labor of man and beast, for example acre (piece of land a man could plough with one team from morning till evening), yoke (a day's labor of a team of oxen in a yoke), bushel seed, load seed (field for which a bushel, respectively a load of corn is required for sowing), etc. Also for measures of volume, space and masses similar conceptions are found. With regard to the latter names may be mentioned as load (mass which a man can just carry), corn (granum), carat (Kuara, weight of the corn in the pod which was used in Africa for weighing gold, in East-India for weighing diamonds). These examples could be extended indefinitely, the above named, however, give a sufficient proof of the abundance of natural quantities and their variety, as well as their lack of inter-relation.

The setting up of units chosen to meet special requirements and without inter-connection do not form a measuring system even though the quantities otherwise serve excellently for certain applications. On the contrary it is required that in a measuring system the principal units are limited to a minimum and that they bear clearly recognizable relations to the secondary units. That measuring system in which these relations are absolutely clear and so simple that from one unit, all others can be derived without difficulty must be recognized as the best. Further, the sub-units should have, as convenient as possible a numerical ratio to the principal and secondary units.

As a rule, the unit of length is the fundamental and principal unit for building up a measuring system. From the unit of length, the unit of area and of volume is derived. The former is a square with the unit of length as the side, the latter a cube with the unit of length as the edge. The mass of a certain material—as a rule, pure water in the state of its greatest density is used for this purpose—which is contained in the unit of volume or in a sub-unit of it, is taken as the unit of mass. Very often the unit of mass is chosen as the fundamental and principal unit. It is taken to be equal to the mass of a body selected from nature or to a certain quantity of bodies, for example grains of barley. The cube filled with the material, for example water which balances the mass unit then forms the unit of volume, the surface of this cube the unit of area, and the edge of the cube or the side of the area the unit of length. In these measuring systems, no provision is made for the third fundamental unit, that of time, but there are measuring systems which start from the unit of time or at least include it.

Among the numerical relations of sub-units to principal or secondary units, three are of special importance: the division in 2, the division in 10, and the division in 12. The simplest and most natural division is the division in 2 or, as it is also called, the continued halving. The child already divides a quantity into equal heaps, these again in two equal parts, and so on. Due to the fact that the division by 2 is so natural it will be retained by the great masses in all measuring systems whichever numerical system has been introduced to them. This need for continued halving was taken into account in Germany by the August 17, 1868 ordinance of weights and measures though only for the volumetric measures by admitting 1/4, 1/8, 1/16, and 1/32 liter. Even the May 30, 1908 ordinance of measures and weights admits it if only in a roundabout way because the 1/4 and 1/8 kg which are permitted do not fit into the metric system even though, as it is done now, the designation in grams—250 g. and 125 g.—is prescribed for the respective weights.

In the English system the division by two is still prevalent today. The division by twelve (duodecimal division) has the great advantage that its fundamental number is divisible by five factors, 2, 3, 4, 6, 12, so that sub-units to the amount of 1/2, 1/3, 1/4, 1/6 and 1/12 of the principal unit can be formed which in many cases is desirable. It has been applied for example by subdividing the foot into 12 inches of 12 lines. The division by ten (decimal, decade system) is based on the same fundamental number as our Arabic numerical system which, as is known, is derived from the ten fingers. This agreement brings with

it an extraordinary simplification in calculations and, therefore, a great saving in time. The advantages of the decimal system are, however, so well known that they require no explanation. The disadvantage of the decimal division consists in the small divisibility of the fundamental number 10 which can be factored only by 2, 5 and 10, so that only three fractions, 1/2, 1/5, and 1/10, can be formed. Since the public usually does not calculate with fifths and tenths the division by two is always used in all systems based on ten as fundamental number, and cannot be eradicated.

2. EARLY MEASURING SYSTEMS

Of the measuring and weighing systems of antiquity, only one need be mentioned, namely the Babylonian, because it was, in all probability, the starting point for all other systems and was valid, at least in one of its units, perhaps up to very recent times. In old Babylon the mass-unit was the fundamental unit and for subdividing the division by sixty (sexagesional system) was used. Unit of mass was the weight of a certain amount of water, the talent. The edge of a cube enclosing this amount of water, is the Babylonian foot. The talent was divided into 60 mines. The half of the Babylonian mine is said to have been retained to recent times in the unit of medicinal weight, the Nuremberg apothecary pound.[21]

In the more recent systems, the measures of length have precedence; the unit is as a rule, the foot. A definite, but for every country changing fraction of the mass which is contained in a cubic foot of water, is fixed as unit of mass. Besides these there existed a great number of measures for special purposes the connection of which with the principal units could be proved only with difficulty or not at all.

The Prussian System. One of the best-founded systems with respect to the embodiment of its units was very likely the one used in Prussia. Unit of length was the Prussian foot. According to the May 16, 1816 ordinance of measures and weights, the Prussian foot was to contain 139.13 lines of the Parisian foot. But in order to have the size of the Prussian foot measure based on an original quantity which could be independently reproduced at all times when doubts arose, it was determined that, after having finished the observations of the length of the seconds-pendulum at Berlin, this length and its relation to the Prussian foot should be publicly made known. Further, a standard measure was to be made and kept at the Ministery of Finances and Commerce as the only authorized measure in the Prussian State. Three exact replicas of the original standard under the same supervision were to be deposited at the Royal Building Commission, at the Mathematical Class of the Academy of Science, and at the Supreme Court. These four rods were made of iron by Pistor and had a length of 3 ft. 7 lines (956.81 mm), a width of 14.6‴ (31.8 mm), and a thickness of 4.9‴ (10.77 mm). They indicated the length of 3′, the subdivision into 36″, and the subdivision of the last inch into 12‴ by lines which intersect vertically two other lines drawn at a distance from one another of about 0.4‴ the whole length of the rod on one of its wide sides. The lines are drawn on silver, for the inches on pins of this metal which are driven into holes drilled through the whole iron, for the line (‴) on an inlaid plate of silver.

[21] See Karston: "Mass und Messen" for older measuring systems, and the literature cited there

The rods were to be compared with one another every ten years. The work on the relation of the original measure with the French foot measure and the pendulum length at Berlin, as also the determination of the latter and the comparison of the rods was carried out by Bessel.[3] Out of theoretical and practical considerations the scientist was, however, instigated to propose, as Prussian original measure, a definite measure of length in place of the measure with lines, and in the "law for the original measure of the Prussian state with respect to the law of May 16, 1816" it states: The basic measure for the Prussian foot is that unit which was derived in the year 1837 from the French foot by assuming it to be legally equal to 139.13 lines. "The length of the Prussian foot is determined solely by this original standard, namely the distance between end faces of sapphires set in the axis of the standard and measured at a temperature of 16.25° C which is, under these conditions, 0.00063 lines shorter than 3 Prussian feet. This explanation of the Prussian foot is the only authentic one." This original standard was deposited at the Prussian Ministery of Commerce and is now in possession of the Physikalische-Technische Reichsanstalt, Section I for measurements and weights. The length of the seconds-pendulum at Berlin, expressed by the original standard was fixed at 456.1629 lines. By this measurement, the length of the Prussian foot was made independent of the French units. All work in connection with the determination of the new original standard was also made by Bessel. A description of the rod is given later. In marine matters, the fathom of 6 ft. and in mining the "Lachter" of 80" was used, for the selling of dry goods the ell of 25.5 inches. The foot was subdivided into 12 inches of 12 lines = 0.31385 m. As a measure of distance the mile of 2000 Ruten of 12 ft. = 7.5325 kilometers served. Unit of area was the Prussian or Madgeburg acre of 180 square Ruten area = 25.532 acres. Otherwise, the squares of the measures of length were valid. The unit for liquid measure was the Berlin quart of 64 cubic inches = 1.145 liters, for dry measure the bushel of 3072 cubic inches = 54.961 liters, 20 quarts = 1 anker, 2 ankers = 1 pail, 2 pails = 1 ohm, 3 pails = 1 Oxhoft, 4 Oxhoft = 1 Fuder, 100 quarts = 1 beer keg, 24 bushels = 1 wispel, 1 bushel = 16 Metzen, 1 ton linseed = 37 2/3 Metzen, 1 cord wood = 108 cu. ft., 1 ton (salt, coal, etc.) = 4 bushels. 1 Schachtrute = 144 cu. ft., 1 Kummt peat = 138.36 cu. ft.

Unit of mass was the pound = 467.711 grams. It was the 66th part of the mass of 1 cu. ft. of water of 15° Reamur temperature, weighed in vacuum. 1 cu. ft. of water weighed, therefore, 66 lbs. As standard pound, a gold-plated brass weight made by Schaffrinsky was used which, in the year 1817, was compared in Paris by Humboldt and Arago with a platinum replica of the kilogram in the Archives. The pound was divided in 32 lots to 3 quentchen. 100 pounds = 1 hundred weight. By the law of May 17, 1856, the "Zollpfund" of 500 grams was introduced in Prussia for general commerce and thus the relation of water unit to length unit abandoned. The "Zollpfund" was divided in 30 lots of 10 quentchen of 10 cent of 10 grains. 100 lbs. = 1 hundred weight, 40 hundred weight = 1 ship load. Besides the commercial weights there was

3) Bessel: Description of the investigations and rules which were made necessary in the years 1835 to 1838 by the unit of the Prussian measure of length.

still a special gold and silver weight, the Prussian Mark, corresponding to half of the old Prussian pound or 233.8555 grams. It was divided, for gold, into 24 carats of 12 grains, for silver, into 16 lots of 18 grains; it had, therefore, for both metals 288 grains. As weight for coinage also the Prussian Mark of 288 grains was used. For jewels, the Prussian carat was used which was divided, according to the halving system, into 1/64's carat. Its value was 205,537 milligrams so that 160 Prussian jewel carats equalled nine old Prussian quentchen commercial weight. The Prussian apothecary pound had 12 ounces of 8 drams of 3 scruples of 20 grains, i.e. 5760 grains. It was equal to 24 lots, equal to 3/4 old commercial weight or 350.783 grams. The ounce had 2 lots, the dram 1 old quentchen. This enumeration leaves nothing to be desired as regards variety, and yet, here are only mentioned measures and weights of the old provinces in which the Prussian law of weights and measures of May 16, 1816 was valid. If also those parts of the country were taken into account which joined in 1864 and 1866, double the number could easily be obtained, especially for the dry measures.

As in Prussia, so also in the majority of the German states the foot was divided into 12 inches of 12 lines the standard unit of length; only in a few states, as in Wuerttemberg, Baden and the Grand-Duchy of Hesse, the decimal division was introduced in the beginning of the 19th century. The length of the foot changed from country to country, and in some, especially in the Thuringian States, even from place to place. The longest foot was the Rhen-Bavarian with 0.33333 m., then follow: Rhemish foot 0.31385, Nuerenberg 0.303, Baden, Nassau 0.30000, Augsburg 0.29617, Oldenburg 0.29588, Hannover 0.29209, Munich (old Bavarian foot) 0.29186, Bremen 0.28935, Hess Electorate 0.28770, Luebeck 0.28763, Mecklenburg-Schwerin, Schleswig-Holstein, Hamburg, Hohenzollern, Wuertemberg approximately 0.286, Frankfurt-on-Main, Hessen-Homburg 0.28461, Kingdom of Saxony 0.28319, Grand-Duchy Hesse 0.25000 meters. This tabulation does not claim to be complete.

In the units of areas, generally only the squares of the units of length appeared in addition to the acre. The dry measures show in most cases the division by two which, however, is seldom so strictly carried through as in Hesse where the "Malder" was fixed to 4 Simmer to 4 Kumpf to 4 Gescheid to 4 Maesschen, and the Mass equal to 2 bottles to 2 Schoppen; in general, accidental conditions prevail corresponding to local usages.

In the measures for mass, the unit was everywhere called the pound but this pound had a weight for example: in Prussia of 467.71 grams, in Bavaria (Munich pound) of 560 grams, in Bavaria 500, Hannover 489.57, Hamburg 484.12, Saxony 467.14, Wuerttemberg 467.75, etc. Just as different were the subdivisions of the pound, here in 30 lots at 10 quents to 10 cents to 10 grains, there in 32 lots of 4 quentchen or also in 4 quadruplets of 8 lots, in 100 quent of 10 overtchen, in 10 lots of 10 quint, etc., etc. The divisions in two, ten and twelve, and also the old sexagesimal division are applied here, but none in actual purity, as is the case for the units of length and generally for the units of dry measure.

For science and industry, aside from the metric system, only the old

French system and the English system are of interest, in addition to the old German.

The Old French System. In the old French system, the foot (pied du roi) formed the unit of length and was, at the same time, the fundamental unit. The foot of 0.324839 meter was divided in 12 inches (pouce) of 12 lines (ligne) of 12 points (point). The unit of distance was the mile (leiue) which existed in dozens of varieties. The most generally applied was the common mile (lieue de 25 au degre) of which 25 were to make up one degree at the equator.

Unit of mass in the old French system was the weight of the mark (poids de marc). The pound (livre) had 2 marcs of 8 ounzes (onces) of 8 gros or drams (dragmes) of 3 pennies (deniers) or scruples (scrupules) of 24 grains (grains), i.e. 9216 grains or 489.5058 grams.

The unit for the weight of jewels which was maintained up to recent date independently besides the metric system, was the carat of 4 grains = 205.5 milligrams which was subdivided, as in Germany, in pure division by two to 1/64.

It needs hardly be mentioned that besides the mentioned measures and weights a very great number was still in use for special purposes or of purely local importance.

The English System. The English system of measures and weights, and also the Russian, is based on two fundamental units, the units of length and mass while in the Prussian System all other units are derived from the unit of length. It is the oldest system, and goes back for its origin to the 12th century. In the meantime, however, revisions have been made several times, the replicas especially, have been replaced several times.

The conception valid at the present time of the yard as unit of length has been given by the law on measures and weights of 1878. According to it, the yard is the straight line distance between the centers of two gold pins in the bronze rod which according to the law, is to represent the Imperial Standard Yard if the rod has a temperature of 62° F. The bronze rod has a length of 38 inches and a quadratic section of one inch side. Near the ends, a distance of 36 inches between centers, a cylindrical hole of 3/8 inch diameter is drilled to a depth of 0.5 inch. At the bottom of each hole, a thin cylindrical pin of gold is inserted of about 0.1 inch diameter, and on the surface of the pin three fine lines are drawn at a distance of about 0.01 inch apart at right angles to the axis of the rod and two lines the same distance apart parallel to the axis of the rod. The length of the Imperial-Standard-Yard is represented by the distance between the middle perpendicular line on the one and the middle perpendicular line on the other end.

The subdivisions are the following: 1 yard equals 3 feet of 12 inches of 12 lines. Two yards equal one fathom, 5.5 yards equal 1 rod, 4 rods or 100 links or 22 yards equal 1 chain, 40 rods or 200 yards equals 1 furlong, 8 furlongs or 1760 yards are one mile. The foot is also divided in quarter, eighth, sixteenth, or in tenths, hundredths, thousandths.

Besides the legal statute mile of 1760 yards, there are still used as a measure of distance the London mile, or British mile of 5000 ft. or 1666 2/3 yards, and the sea mile or English geographical mile—in con-

trast to the German geographical mile—also called knot, nautical mile which, at the same time, is the nautical mile of all sea-going nations, and is 1/60 of a degree at the equator or 2028.633 yards. Three of these miles are one league so that there are also three leagues of different lengths.

Unit of area is the square yard of 9 feet of 144 square inches, 30¼ sq. ft. or 272¼ sq. ft. are the square rod, 40 square rods equal 1 rood, 4 roods or 4840 sq. yards. equal one acre of land, 640 acres are one square mile.

Unit of volume is the cubic yard. It has 27 cubic feet of 1728 cu. in. The ship register ton has 100 cu. ft.

The unit of dry measure is derived from the unit of mass. According to the law of measures and weights of 1878, as the unit of mass is taken the weight in vacuum of that piece of platinum which has been recognized by that law as the Imperial-Standard-Pound. It is represented by a cylinder of 1.35 inch height and 1.15 inch diameter. The law of 1878 states further: 1/16 of the Imperial-Standard-Pound is to be one ounce, 1/16 of such ounce is to be one dram, and 1/7000 of the Imperial-Standard-Pound is to be one grain. One stone shall have 14 Imperial-Standard-Pounds, one hundredweight shall have 8 of such stones, and a ton shall be 20 of such hundredweights.

The apothecary weight is regulated by an order in council of August 14th, 1879. One pound has 16 ounces of 437½ grains, but according to the British Pharmacopoeia of 1898, also the ounce of 8 drams of 3 scruples of 20 grains is admissible.

The two original standards are deposited in the Department of Weights and Measures of the Board of Trade. In order to safeguard the system in case of inquiry or destruction, four legal replicas (Parliamentary copies) of same shape and make, were made at the same time, of which one each, yard and pound, are kept in the Royal Mint, in the Royal Society of London, in the Royal Observatory at Greenwich, and in the new Westminster castle. Should anything happen to the original standards, which makes their further use doubtful, one of the replicas which appears still to be suitable shall take its place, or, the original standard can be restored and compared with the replicas.

A check from outside of the system has been created in that, in the year 1895, two replicas of the Imperial-Standard-Yard one rod of bronze and one of platinum-iridium were compared with two replicas of the International Meter prototype, at the Bureau International des Poids et Mesures. Also, in the year 1902 a yard rod was made of the same x-shaped section and of the same material (platinum-iridium) as the original metric prototypes, and compared with both the International Meter Prototype and the Imperial-Standard-Yard. This rod on which both the length of the yard and that of the meter is indicated and which deviates from the Imperial-Standard-Yard at 162/3°C of the International Hydrogen Scale of 100 degrees by only + 0.000226 English inches, is now the real embodiment of the yard.

"The unit of volumetric measurement from which all other volumetric measures for both dry and liquid materials are derived shall be the gallon. It contains 10 Imperial-Standard-Pounds of pure water weighed in air with brass weights, at a water and air temperature of 62° F. and an air

pressure of 30 English inches." The quart shall be the fourth and the pint the eighth part of the gallon. Two gallons shall be one peck, 8 gallons one bushel, and eight such bushels shall be one quarter and 36 bushels one chaldron. When used the measure shall be level full, not heaped full. Others than those named before are no longer admitted in public traffic.

Special liquid measures are provided for apothecary and medicine purposes the unit for which is the fluid ounce. It contains 437.49999 grains of pure water at a temperature of 62°F. and an air pressure of 30 English inches. The fluid ounce has 8 fluid drams of 60 minims, 20 fluid ounces are one pint, 8 pints or 160 fluid ounces are one gallon.

Besides the British measures and weights, the metric system is selectively admitted by the law of measures and weights of 1897. In science and for pharmaceutical purposes it is used almost exclusively but has otherwise found little application.

In the shape given it by the law of 1878 and greatly simplified by it, the English system of measures and weights makes, if not a perfectly logical, yet a very clear impression. It can, however, not be overlooked that even today still a great number of provincial and special measures are in use besides the lawful ones, the abolishment of which has so far been futile. Very often the illegality in the use of such units has been hidden by giving them a simple ratio to the Imperial-Standard-Measures.

The American System. The United States of America also use the English System of weights and measures but the progress which has been made in England by the law of 1878 and later was not made there. While England, in 1898, due to the comparisons made in 1895 between yard and meter, legally fixed the ratio between the two systems. 1 English yard = 914.399 millimeters, the United States by law of April 5, 1893, again recognized as sole lawful ratio between American and metric system the equation introduced by the law of July 28, 1866: 1 American yard = 3600/3937 meter. Consequently, the Bureau of Standards in Washington states in its conversion tables published in 1903: 1 American yard = 914.4018 millimeters.

Also for the volumetric units the United States have omitted the transition to the Imperial-Standard-Measures but still uses the old English measures, namely as dry measure the old Winchester bushel of 2150.42 English cubic inches. Of the latter, 131 make up 127 Imperial-Standard Bushels. For liquids, the old wine-gallon has been retained. It has 231 English cubic inches, and 6 American gallons are figured to be equal to 5 Imperial-Standard-Gallons. For the weights on the contrary, England has followed America which from the beginning has used the Cental of 100 English pounds and correspondingly the ton of 2000 lbs. instead of the hundredweight. Also in the States therein exists a strong movement for the introduction of the metric system.

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E. Leitz, Inc. announce that they have opened offices at 122 South Michigan Ave., Chicago, Ill. and 927 Investment Bldg., Washington, D. C.

The St. Louis Motor Valve Company has established a sales office at 246 Fifth Ave., New York, N. Y. This office will be in charge of Arthur B. Schellenberg.

Measurement of Air Flow

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CHAPTER I.

INTRODUCTORY.

In many cases where physical measurements have to be conducted a choice of methods is available, and it is for the experimenter to decide which of these is best adapted to his particular purpose. His selection will be governed by considerations of simplicity, directness, and the degree of accuracy he requires; he should always avoid a complicated method when a simpler one will equally serve his purpose. Let us therefore consider what means are available for the problem with which we are here concerned, namely, the measurement of the speeds of streams of liquids or gases, with particular reference to the motion of air along pipes or ducts. A method that immediately commends itself from the standpoint of simplicity is the introduction into the fluid of some indicator such as a small light body, a puff of smoke, or a drop of colouring matter, which will be carried along by the stream and may be timed over a measured distance. Very little consideration is however needed to show that the difficulties and disadvantages of this method are such as to render its practical application inadmissible, except, perhaps, in a few very special instances. The only other direct method that immediately suggests itself is to collect and weigh the quantity of fluid delivered in a given time, whence the mean speed past any section of known area can be calculated if the density of the fluid is known. This method, which is often employed for the measurement of water flow, is simple and convenient in the case of an incompressible fluid whose density is greater than that of the medium surrounding the pipe or channel in which flow is taking place; for gases, the experimental difficulties are serious, and, in the case of air flowing along pipes situated in the atmosphere, so great as to render the method virtually impracticable.

Editor's Note: INSTRUMENTS has secured the American publication rights of "The Measurement of Air Flow" by E. Ower. This treatise will be published serially in INSTRUMENTS, the first installment appearing in this issue. The complete treatise can be obtained from the INSTRUMENTS' Book Shelf.

It is not intended in this book to deal with the measurement of the flow of liquids; this question has already been fully discussed in numerous treatises on hydraulics, and the methods employed have been standardised for some time. We shall here confine attention to the measurement of air flow only, but it should be observed that the methods described will in general be applicable to the flow of other gases with very little, if any, modification, except as regards the constants occurring in the equations to be derived. For our purpose, as we have seen, direct methods are inapplicable, and it is therefore necessary to resort to the measurement of some physical effect arising from the motion. Three such effects have been found by experience to be suitable, namely, pressure changes associated with the motion; mechanical effects, such as the rate of rotation induced in light vanes suitably mounted in the stream; and lastly, the rate of cooling of a hot body, such as an electrically heated wire, introduced into the air current. Of these, the first is of the greatest importance, since, as we shall see later, a properly designed instrument, suitably inserted in the stream, experiences a pressure, commonly called the "velocity head," which is entirely characteristic of the motion, and can be measured on a suitable pressure gauge. If such an instrument is constructed in accordance with certain well-established principles, which are fully explained below, its constant is known and it may therefore be used without calibration as a standard for the measurement of air speed. This is not true of anemometers * which depend for their action either on mechanical or on electrical effects; instruments of both these types are subject to individual variations and require calibration against a standard instrument of the pressure measuring type.

Those instruments of the first class which measure the velocity head are known as pressure-tube anemometers, and are more extensively used in practice than any other type. Other devices which involve the measurement of pressure differences are orifice plates, Venturi tubes, and nozzles. It should be noted, however, that these measure not the velocity head, but pressures which depend on the dimensions and form of the instruments themselves as well as on the motion of the fluid through them. They cannot therefore be used as standards, but require calibration.

Mechanical anemometers comprise three main types—cup, swinging-plate, and vane anemometers The first two of these are not of importance to engineers, and no attention beyond the following brief description will be devoted to them here.

* The word "anemometer," as its derivation implies, is a term which includes all types of instruments used for the measurement of air speed.

The vane anemometer, on the other hand, which is fully discussed in Chapter VII., is a convenient instrument for practical use and has a comparatively wide field of application.

In its most common form the cup anemometer consists of four hemispherical cups carried, with their bases vertical, at the outer ends of four light arms which are symmetrically disposed in a horizontal plane and are attached to a central sleeve free to rotate about a vertical axis. The cups are arranged in pairs so that the concave side of one member of a pair is presented to the air current at the same time as the convex side of the diametrically opposite cup. At any instant, then, the air on one side of the median plane through the vertical axis of the instrument will be blowing into the interior of one or two cups, and on the other side of this plane on the exterior of the opposite cup or cups. Hence, since the aerodynamic force on a cup with its concave side presented to the wind is greater than when the wind is blowing on its convex face, rotation will ensue at a rate depending on the wind speed. Instruments of this type are bulky and not easily portable; they are chiefly used in meteorological work.

The swinging-plate anemometer consists of a vertical plate, suspended on knife edges, which deflects under the action of a wind to such an angle that the restoring torque due to the weight of the plate is equal to the wind torque. The angle of inclination may therefore be taken as a measure of the air speed. Alternatively, the plate may be mounted on a torsion wire passing through an asymmetric vertical axis; in this case there will be a relation between the wind speed and the amount of twist of the wire necessary to bring the plate into normal presentation to the wind.

Electrical or hot-wire anemometers have not hitherto been very extensively utilised, although certain types have been developed for industrial application. The chief factor militating against their wider use would appear to be the more elaborate apparatus and manipulation that they entail. As laboratory instruments, they may be made to give excellent results, and they are, in particular, well suited to the measurement of low air speeds, a purpose for which they may be designed to have a considerably more open scale than is possible with pressure-tube anemometers.

CHAPTER II.

GENERAL PRINCIPLES OF THE PRESSURE-TUBE ANEMOMETER.

A. Practical Considerations.

Although theoretical analysis is always necessary for the complete elucidation of natural phenomena, it is useful to

consider also the practical aspects, in order to enable the physical meaning of the symbols and equations occurring in the analysis to be fully interpreted. For this reason an attempt will be made in the first part of the present chapter to explain from a practical standpoint the principles upon which the action of the pressure-tube anemometer depends. It must not be supposed, however, that the following remarks are intended to convey anything more than a rough mental picture of what occurs. Certain material considerations, which must be included in a complete discussion of the subject, have been neglected for the present, the more theoretical treatment being reserved for a later stage.

The natural starting-point is the consideration of the pressures that exist in a moving fluid, and it is in the conception of these that a good deal of confusion exists amongst practical engineers. For convenience, the pressure of the undisturbed atmosphere—the barometric pressure obtaining at the time and place of measurement—is usually taken as the datum or zero pressure, and all pressures are expressed in terms of the number of units (usually in England inches of water) by which they exceed or fall short of this arbitrary datum. It follows that pressures less than atmospheric will be recorded as negative pressures, but it must be remembered that such pressures are actually positive: the true zero of pressure is, of course, the absolute vacuum, and it is not possible to conceive of a pressure less than this. Except where otherwise stated the customary convention regarding the use of the atmospheric pressure as a datum will be followed in this book, so that it will sometimes be necessary to refer to negative pressures; if the above remarks are borne in mind, however, no confusion will arise.

It is well known tnat at any point in a stationary fluid a definite hydrostatic pressure exists which acts equally in all directions. If now this fluid is set in uniform, unaccelerated motion, the hydrostatic pressure will still persist although its actual magnitude may be changed, and if we imagine a very small thin plane area placed at any point in the fluid, and moving with it, this "static" pressure, as it is called, will act on the two faces of the plane. Let us assume that there is a continuous stream of the fluid in movement, and that the motion is uniform and does not vary with time, so that at any section perpendicular to the current the conditions are constant. If, instead of moving with the fluid, the small area remains stationary at a point in the section under consideration, and if, moreover, the area is held with its plane parallel to the direction of motion, it is clear that the pressure acting on the two faces will be the static pressure existing at that point in the section of the fluid, provided that the presence of the plane does not disturb the conditions of flow.

Let us now consider what occurs if the area is rotated so that the stream impinges normally on one face ; when the area moves with the stream, it will again be acted upon by the static pressure only, but if it is held stationary at a given point its front face will experience the static pressure and an additional pressure arising from the impact of the moving stream. It is important to observe that this additional impact pressure is entirely characteristic of the motion, depending, as it does, for a plane area of given size, on the speed and density of the fluid only, so that it can be utilised as a measure of the speed.

It appears therefore that if the plane is placed normally to the stream, so that the forward motion of the fluid impinging on it is arrested, the pressure exerted will be the sum of the static and the impact pressures at the point in the fluid at which the plane is situated ; whereas if the plane is placed so that the fluid streams past it without disturbance the static pressure only is experienced. Suppose now that the imaginary plane area is replaced by an open-ended tube of small bore bent to face the stream, and that the other end of the tube is connected to one limb of a simple U-tube pressure gauge, the other limb of which is open to the atmosphere. The forward motion of the fluid impinging on the open end of the tube will again be arrested, and the pressure gauge will record the sum of the impact and static pressures, or the " total head " as it is commonly called (see Fig. 1). It is found by experiment (see below) that

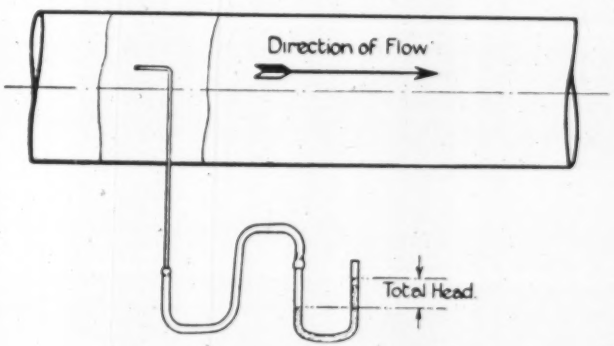


FIG. 1.—Measurement of total head.

the impact pressure measured by a facing tube is, within wide limits, unaffected by the shape and size of the tube, and is, in fact, equal to the " velocity head " or " velocity pressure " to which reference has already been made in Chapter I. The relation that exists between this pressure and the density and velocity of the fluid will be derived in the second part of the present chapter ; at this stage it is sufficient to observe that the velocity head is a function of the motion only.

We see therefore that whereas the velocity head is uniquely

determined by the speed * of the fluid, the static pressure is not; it follows that the total head in the same fluid may, under two different sets of conditions, be different although the speed in each case may be the same, so that, in order to determine the speed, it is necessary to measure both total head and static pressure, since the velocity head cannot be observed separately.

As an example of two instances in which a fluid moves at the same speed but gives different values of the total head, we may consider the case of air which is being moved along a given pipe by means of a fan. It is clear that the air may be made to travel at the same speed whether the fan is blowing or exhausting down the pipe, and the velocity head will be the same in the two cases. The static pressure in the pipe when the fan is blowing, however, will be higher than atmospheric, and lower when the fan is exhausting, so that the total head under the former condition will be higher than that under the latter.

Reverting now to a consideration of the open-ended tube facing an air stream, we see that the pressure gauge to which it is connected will indicate the sum of the velocity and static pressures of the air at the mouth of the tube. If, therefore, the other side of the gauge is connected to a tube or other device which in some manner measures the static pressure, the reading of the gauge will be equal to the difference between the pressures acting on the two sides, i.e. to the velocity pressure, and will thus serve directly to determine the air speed.

It is upon this principle that all pressure-tube anemometers depend. For the measurement of the total head, any form of open-ended tube facing upstream will be reliable, but some care is necessary in the design of the device for measuring the static pressure. The important condition to be observed is that, in the region where the static pressure is measured, the air must not have a velocity component perpendicular to its original direction of motion before the tube was inserted; in other words, any device for measuring static pressure will give erroneous results if it deflects the air to any appreciable extent. The design of static pressure tubes is fully discussed in the next chapter; at this stage it is sufficient to note that it is, in fact, possible to make a static tube which measures the static pressure to a degree of accuracy well within practical requirements. Such a tube, suitably used in conjuction with a facing or total head tube constitutes a complete pressure-tube anemometer which does not require calibration, save in exceptional cases, and therefore serves normally as a fundamental standard in-

* We shall, for simplicity, neglect in this section the effect of variations in density, which is small under conditions usually occurring in air speed measurements.

strument for the measurement of air speed.

Anemometers of this nature are extensively used in practice. The only disadvantage inherent in this method of measurement is that the velocity pressure corresponding to low air speed is small: a speed of 20 feet per second, for example, only produces a pressure of about 0·09 inch of water. It follows, therefore, that sensitive pressure gauges or "manometers" are necessary for the measurement of low speeds. In fact, for air speeds below about 15 feet per second it is often advisable to use some other measuring device, such as the vane anemometer, the orifice plate or Venturi tube, or, in some cases, the hot-wire anemometer.

B. Elementary Theoretical Considerations.

In general, the theoretical treatment of problems of fluid motion is extremely complex and demands intricate mathematical analysis, so that only in a few isolated instances of simple motions have theoretical solutions hitherto been found. It is, however, often possible, by the introduction of simplifying assumptions, and with the assistance of experimental research, to deduce relationships, sufficiently accurate for most purposes, between the various properties of the fluid that govern its motion. Such methods have been found to be especially fruitful in the treatment of the flow of liquids and gases in pipes—the particular type of fluid motion with which we are here mainly concerned.

Attempts to visualise conditions of flow are aided by the introduction of the conception of "stream lines." In any mass of moving fluid we assume the field to be mapped out by a system of lines such that the direction of one of these lines at any point coincides with the direction of motion of the particle of fluid situated at the chosen point at the instant under consideration. The stream lines will thus give an instantaneous picture of the flow at any moment. If the flow is unsteady, so that it varies with time, this picture will change from instant to instant; it may, in the case of periodic motion, undergo a series of changes which recur at regular intervals. For steady flow, on the other hand, the stream lines will preserve their configuration unchanged at all instants, and will show the actual paths of individual particles of the fluid. This type of motion is known as "stream-line" motion, the unsteady variety being termed "turbulent" flow. As we shall see later, both types of flow are possible in pipes, although in practice the latter type occurs by far the more frequently.

A complete mathematical analysis of a case of fluid motion must take into account all the properties of the fluid that influence the flow. It would, however, appear to be justifiable to neglect certain of these properties if the treatment can

thereby be appreciably simplified and if, at the same time, it can be shown that the results apply sufficiently closely to actual conditions. Comparison with observation has shown that a certain law, which is of fundamental importance in the flow in pipes, may be simply deduced by neglecting the viscosity of the fluid, i.e. by assuming that no frictional forces occur between adjacent particles of the fluid, or between the fluid and any solid boundaries with which it is in contact. A fluid of this type is called an inviscid or perfect fluid, and the law in question is named after Bernouilli, by whom it was first stated in 1738. It may be derived in the following manner.

Let ABCD (Fig. 2) represent a longitudinal median section through a tube of fluid bounded by stream lines. (Such a tube is termed a stream tube, and AB and CD are two of the bounding stream lines.) For steady motion, the boundaries of the stream tube will preserve a constant shape, although the actual fluid in the tube will be continually changing.

Consider a small element PQRS of the tube of length ds which is so small that the elements PS and QR of the stream lines may be considered as straight lines. If v and p are respectively the speed and pressure across the section PQ, we may, since ds is small, write $v + dv$ and $p + dp$ for the corresponding quantities across section RS, where dv and dp are small.

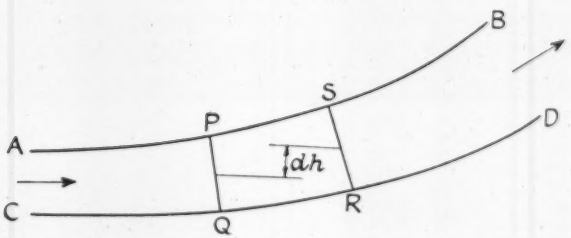


FIG. 2.

Let a = area of section PQ,
Δ = weight of unit volume of liquid,
g = acceleration due to gravity,
dh = difference of level between the centres of area of PQ and RS.

If second order quantities are neglected, the resultant force along the axis of the tube due to the pressure on the faces of the element can be shown to be equal to adp, acting in the direction opposite to that of the motion. To this must be added the force acting in the same direction due to the weight of the fluid in the element PQRS. The latter force is equal to Δadh acting

on PQ and is zero on RS, the resultant being Δadh. The sum of these forces is equal to the rate of change of momentum through the element. The mass of fluid entering per second across PQ is given by $\frac{\Delta}{g} av$, and, since PS and QR are stream lines, the mass leaving at RS is also $\frac{\Delta}{g} av$, so that the change of momentum per second is $\frac{\Delta}{g} avdv$, in the direction of motion.

We therefore have the equation

$$\frac{\Delta}{g} avdv = -adp - \Delta adh,$$

or

$$\frac{\Delta}{g} vdv + dp + \Delta dh = 0. \quad . \quad . \quad . \quad (1)$$

The quantity $\frac{\Delta}{g}$ is usually denoted by ρ, so that (1) may be written

$$vdv + \frac{dp}{\rho} + gdh = 0.$$

On integration this equation becomes

$$\frac{v^2}{2} + gh + \int \frac{dp}{\rho} = \text{constant} = C, \quad . \quad . \quad (2)$$

which applies to all sections of a given stream tube. The quantity h may be taken as the height of the section measured above any arbitrary datum. An alteration in the datum level will merely involve an alteration in the value of C for the stream tube. When the stream tube becomes infinitely narrow it may be considered as forming a stream line, and we may therefore say that equation (2) gives the relation between pressure and velocity along a stream line.

If the flow is horizontal, the datum level may be taken as being that of the stream line itself, and h becomes zero. In practice, when dealing with the flow of air it is almost invariably found that the quantity gh is negligibly small in comparison with the sum of the other two terms of equation (2), so that the simplified form of this equation, viz.,

$$\frac{v^2}{2} + \int \frac{dp}{\rho} = C, \quad . \quad . \quad . \quad (3)$$

which is strictly only applicable to the case of horizontal flow, may generally be used without appreciable error. In the following treatment we shall therefore not consider differences

of level.

A further simplification can generally be made, namely, to treat the fluid as incompressible, so that ρ is constant and (2) becomes

$$\tfrac{1}{2}\rho v^2 + p = C, \quad . \quad . \quad (4)$$

which is Bernouilli's equation in the form most commonly used in practical work. For air, the effect of compressibility can be neglected up to speeds of about 200 feet per second, so that (4) holds for all conditions ordinarily encountered.

On consideration it will be seen that both terms occurring on the left-hand side of (4) have the dimensions of force per unit area, i.e. of a pressure; the first term is the quantity we have called the velocity head, the second is the static pressure, and the sum of the two is the total head. Bernouilli's equation is therefore equivalent to the statement that the total head along a stream line is constant. This equation has been derived on the assumption that the flow is frictionless, but it can be shown that it holds also for the stream line flow of a viscous fluid. Further, experiments indicate that it can be applied with good accuracy in many cases of turbulent flow of actual fluids.

We may now consider the behaviour of the facing tube in the light of Bernouilli's equation. If a stream line is brought to rest by causing it to impinge on a small obstacle introduced into the fluid, the pressure p_1 acting on the obstacle will, if the latter be assumed to be so small as to affect the one stream line only, be equal to the total head at that point in the free stream before the obstacle was introduced, i.e.,

$$p_1 = \tfrac{1}{2}\rho v_0^2 + p_0, \quad . \quad . \quad . \quad (5)$$

where v_0 and p_0 are respectively the velocity and static pressure at the point in the unobstructed stream.

This pressure p_1 will be the pressure acting at the mouth of an open ended tube facing the stream. Theoretically this is only true if (*a*) the tube is so narrow that one stream line only is brought to rest, (*b*) flow through the tube is prevented, as it is if the other end is connected to a manometer, (*c*) the effects of viscosity on the action of the tube can be neglected, and (*d*) the tube does not disturb the flow. Of these, condition (*b*) is the only one which can be definitely fulfilled, and the fact that a tube of finite size facing the air current does actually measure the total head rests not upon a rational theoretical basis but upon a large amount of carefully obtained experimental evidence. Such experiments show beyond doubt that the total head is accurately measured by a facing tube even in turbulent flow, and further that, provided it has an orifice facing upstream, variations in the size and shape of the

tube within wide limits are not accompanied by any errors in the readings. As regards the effect of viscosity, experiments by Miss Barker * have demonstrated that this can be neglected except for very small tubes working at very low speeds, outside the range ordinarily encountered in practice.† It seems therefore that the facing tube will give an accurate reading of p_1 under practical conditions, although theoretically this result could only be expected for the stream-line flow of a perfect inviscid fluid with an infinitely small tube.

Now we see from (5) that p_1, the total head at the point occupied by the mouth of the facing tube, is equal to the sum of the velocity head and the static pressure in the undisturbed flow at that point. If therefore p_0 is measured by a properly designed static pressure tube connected to the other side of the same manometer to which the total head tube is connected, the resultant pressure R indicated by the manometer is given by

$$R = p_1 - p_0 = \tfrac{1}{2}\rho v_0^2, \quad . \quad . \quad . \quad . \quad (6)$$

from which v_0 can be calculated. Details of the method of calculation are given in Chapter V.

Reading of a Total Head Tube at High Speeds.—The equation just derived for the pressure at the mouth of a total head tube is strictly valid only when the fluid is incompressible, but we shall see immediately that it applies with sufficient accuracy for most practical cases of air flow. The general equation which takes account of compressibility, that is, changes of density with pressure, may be obtained as follows.

Before the total head tube is inserted into the stream the pressure and velocity are related according to equation (3), viz.,

$$\frac{v_0^2}{2} + \int \frac{dp_0}{\rho_0} = C. \quad . \quad . \quad . \quad . \quad (7)$$

When the tube is inserted we assume that the velocity at the mouth is reduced to zero and the pressure becomes p_1, so that, by application of Bernouilli's theorem,

$$\int \frac{dp_1}{\rho_1} = C. \quad . \quad . \quad . \quad . \quad (8)$$

We may now equate the left-hand sides of (7) and (8) and thus obtain

$$\frac{v_0^2}{2} + \int \frac{dp_0}{\rho_0} = \int \frac{dp_1}{\rho_1}. \quad . \quad . \quad . \quad (9)$$

* *Proc. Roy. Soc.*, 1922, vol. 101, A., p. 435.

† For air at ordinary temperatures and pressures, viscosity effects on the total head tube may be neglected, provided that the product vd is greater than 0·01, where v is the air speed in feet per second and d the diameter of the tube in feet.

The assumption, which appears to be justified by experimental evidence, is now made that pressure changes are sufficiently rapid to be adiabatic, so that $\frac{p_1}{\rho_1^{\gamma}} = \frac{p_0}{\rho_0^{\gamma}} = K$, where γ for dry air has the value 1·408.

Hence, from (9)

$$\frac{v_0^2}{2} + K^{\frac{1}{\gamma}} \int \frac{dp_0}{p_0^{\frac{1}{\gamma}}} = K^{\frac{1}{\gamma}} \int \frac{dp_1}{p_1^{\frac{1}{\gamma}}},$$

which, on integration and substitution of $\left(\frac{p_0}{\rho_0^{\frac{1}{\gamma}}}\right)$ for K, reduces to

$$\frac{p_1}{p_0} = \left[1 + \frac{\gamma - 1}{\gamma} \cdot \frac{\rho_0}{p_0} \cdot \frac{v_0^2}{2}\right]^{\frac{\gamma}{\gamma - 1}}.$$

Expanding by the binominal theorem we obtain

$$\frac{p_1}{p_0} = 1 + \frac{\rho_0}{p_0}\frac{v_0^2}{2} + \frac{1}{\gamma}\frac{\rho_0^2}{{p_0}^2} \cdot \frac{v_0^4}{8} + \frac{2 - \gamma}{\gamma^2} \cdot \frac{{\rho_0}^3}{{p_0}^3}\frac{{v_0}^6}{48} + \ldots,$$

or

$$p_1 = p_0 + \frac{\rho_0 {v_0}^2}{2}\left[1 + \frac{\rho_0}{\gamma p_0} \cdot \frac{v_0^2}{4} + \frac{(2 - \gamma){\rho_0}^2}{\gamma^2 {p_0}^2} \cdot \frac{{v_0}^4}{24} + \ldots\right]. \quad (10)$$

Now a_0, the velocity of sound in air at pressure p_0 and density ρ_0, is equal to $\sqrt{\frac{\gamma p_0}{\rho_0}}$.

Hence (10) may be written

$$p_1 = p_0 + \frac{\rho_0 {v_0}^2}{2}\left[1 + \frac{1}{4}\frac{{v_0}^2}{{a_0}^2} + \frac{2 - \gamma}{24} \cdot \frac{{v_0}^4}{{a_0}^4} + \ldots\right], \quad (11)$$

which is the general expression for the pressure at the mouth of a total head tube.

For air at ordinary temperatures and pressures a_0 may be taken as roughly 1100 feet per second, and it is then easy to see from (11) that v_0 may be as high as 200 feet per second before the second term in the expansion becomes equal to 0·01. Hence for all speeds below this the second and subsequent terms may be neglected and the ordinary form of (11), viz.,

$$p_1 = p_0 + \tfrac{1}{2}\rho_0 {v_0}^2,$$

may be employed. For very high speeds, exceeding the velocity of sound, Rayleigh * and Stanton † have shown that (11) requires modification on account of the effects of stationary waves, but this point is outside the scope of the present work.

* *Proc. Roy. Soc.*, A., 1910, vol. 84. † *Ibid.*, 1926, vol. 111.

NEW INSTRUMENTS

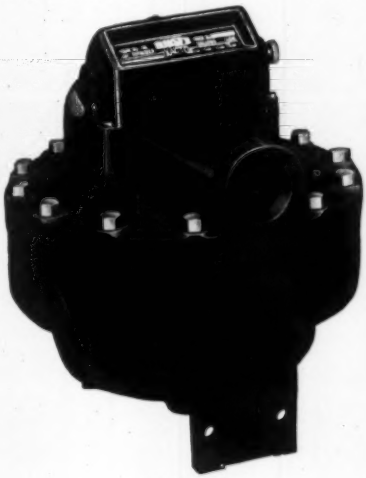
Recently Developed by Instrument Manufacturers

Write Information Section, Instruments Publishing Co., Pittsburgh, Pa., for additional information

New Xacto Meters

THE importance of accuracy in measurement has resulted in an endless procession of precision instruments. The Xacto meter, a device for accurately measuring and recording the amount of liquid flowing through a pipe line, is the recent contribution of S. F. Bowser and Company, Inc., to this procession.

The Xacto meter is of the multiple cylinder type while the principle of positive, volumetric, piston displacement is employed in a unique and yet very simple and effective manner.



XACTO meter.

The original intention was to develop a meter which could be used in measuring deliveries from truck tanks. Inasmuch as most deliveries from truck tanks were made by gravity at varying heads and flows it was a fundamental requirement that this meter be practically free from friction and without slippage. The Xacto meter is the result of this original intention.

Since its perfection however, the field for such a device has been found to be very broad. In addition to being used by oil companies to record the loading and unloading of tank cars and truck tanks it is being used generally for measuring various liquids purchased in tank car lots, measuring the amounts of liquids distributed to various departments or operations, measuring accurate quantities for batch mixing, recording fuel oil consumption on individual burners or on batteries of burners and many other places where an accurate record is necessary. In fact the field for Xacto meter is broadening every day.

One of the outstanding features of the meter is its flexibility. It is manufactured in five different pipe line sizes ranging from ¾" to 3". Flows from 2½ gallons an hour to 12,000 gallons an hour can be handled accurately. The Xacto meter is guaranteed to measure accurately within the tolerances prescribed by the various departments of weights and measures.

Since its entrance to these many fields there has been an increasing demand for it in services other than those cited and for which it was not intended and for which the original meter was not applicable. After these demands became extraordinary, research work was started to develop the original meter into a device to meet these demands.

The most recent developments along these lines are a Meter Barrelling Unit and a One Quantity Pre-Determined Meter.

The Xacto Meter Barrelling Unit, as its name implies is for use in barrelling liquids. It automatically measures, records and discharges any one of three predetermined quantities. The standard quantities are 30, 50 and 55 gallons. While these three quantities fill the needs for most operations where liquids are barrelled they can be changed to meet individual conditions. Provisions are made on the unit to compensate for varying specific gravities and temperatures of the

liquids being handled. The temperature calculation is based on an exact quantity at 60 degrees F.

The rate of discharge is approximately 40 gallons a minute. This enables one

One-Quantity Pre-Determined Xactometer

Xactometer Barrelling Unit

operator to fill approximately fifty 30 gallon packages, thirty-five 50 gallon packages or thirty 55 gallon packages in one hour with an extreme degree of accuracy.

A counter arrangement records the number of packages filled to 10,000 and automatically repeats.

The meter is built into this unit as the measuring and recording device which accounts for the extreme degree of accuracy obtained.

The One-Quantity Pre-Determined Xactometer is the other adaptation of the original meter. It is an automatic measuring device for repeatedly measuring, discharging and recording one fixed, pre-determined quantity of liquid. It is constructed in both a direct control and a remote control type. While in most cases the liquid is handled with pump pressure the meter is designed so that it will operate satisfactorily with either pump or gravity pressure.

One of the particular applications of this model is measuring pre-determined quantities of gasoline, lubricating oil and light greases into tanks, crankcases and transmissions of automobiles on assembly lines.

Practically all commercial liquids with the exception of acids can be handled in all of these devices.

Their perfection has been one more contribution to those instruments of accuracy that are enabling the industrial and scientific world to maintain their continuous march of progress.

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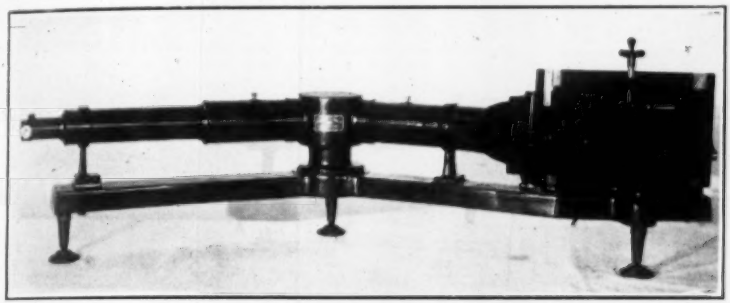
Quartz Spectrograph, Model L251

Littrow Auto Collimating Type

(Gaertner Scientific Corporation)

THIS instrument is suitable for photographing the emission and absorption spectra in the visible and ultra violet regions from 205 $\mu\mu$ to 800 $\mu\mu$ or beyond. The instrument is made of metal throughout and the entire body is mounted on a substantial cast-iron base. Special attention is given in the design and construction to assure convenience in manipulation and long continued service.



The plate holder with slide is made of hard brass, the plate holder cover is made of magnalium, a very strong and light alloy. The seat for the photographic plate and the cover are shaped to the correct focal curve, thus giving the plate the necessary bend. This feature together with the carefully designed optical system of special large aperture, results in obtaining spectrograms of excellent definition and with great photographic speed. The photographic plate is 10x2⅝ inches, about 0.04 inch thick, which size has proven very desirable and has become standard with the larger plate manufacturers. A wider plate when bent in the plate holder has been found bulges in the middle. From 10 to 15 exposures may be obtained on one plate. The setting of the successive exposures is readily accomplished by a coarse screw in connection with a millimeter scale and index. Collimator and camera lenses are made of quartz 50 mm. aperture and 625 mm. focal length.

The dispersing system consists of a Cornu type prism 40 mm. high with faces 65 mm. long. The slit is of the bilateral type with jaws 18 mm. long, made of stainless steel, highly polished, is fitted with a micrometer head and with a slide for varying the length and one for photographing comparison spectra.

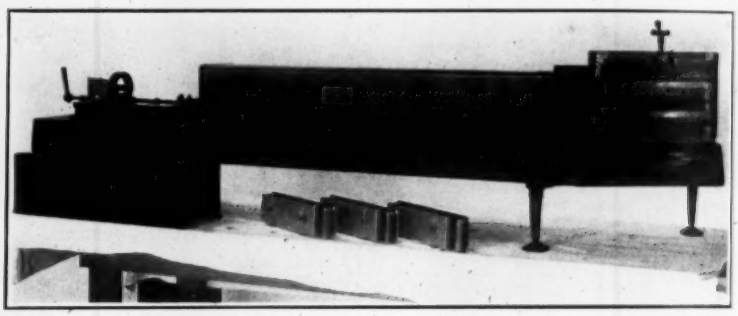
The model L251a spectrograph is in every respect the same as L251 with the exception that a wavelength scale individually ruled is provided with the instrument. By merely turning the lever, contact prints of the scale are made adjacent to the spectrum. A small electric lamp suitably mounted, provides the necessary illumination for the wavelength scale which is automatically switched on when the scale comes in contact with

the plate. This feature eliminates any possibility of accidentally fogging the plate. Time required for the wavelength scale print is about two seconds.

Quartz Spectrograph, Model L253

(Gaertner Scientific Corporation)

THIS form of spectrograph, while not inconveniently large, provides a high resolving power and intensity in the visible and ultra violet regions. The instrument is constructed entirely of metal, thus assuring permanency of adjustment under any climatic conditions. It is mounted on a heavy iron base, two meters long and covered with a steel hood having convenient openings to give access to the optical parts. The dispersion is three times that of L251 and gives the entire spectrum in three sections from 210 $\mu\mu$ to 800 $\mu\mu$ on 10x2⅝ inch photographic plates. Three plate holders are furnished with the instrument each of which is fitted with a seat and cover for the photographic plate shaped to the corresponding focal curve. This feature results in excellent definition throughout the entire spectrum.



The slit is of the new bilateral type, fitted with micrometer head. It is also fitted with slides, one for varying the length of slit and one for photographing comparison spectra. The jaws are 18 mm. long, made of stainless steel, and highly polished. The light entering the slit is sent down the axis by a total reflecting prism of quartz and is collimated by a quartz lens of 70 mm. aperture, and 1700 mm. focal length, and traverses a 30° prism of quartz, of face 100 mm. long, 57 mm. high, coated on the back with tinfoil amalgam. The rays strike this reflecting film nearly normally and so return along the axis of the instrument, the lens focusing an image on the photographic plate. At the same time the rotational properties of the quartz are compensated by traversing lens and prism in two directions. The arrangement is thus equivalent to a spectrograph of the usual type, with similarly dimensioned optical parts, using a 60° Cornu prism.

The setting of the lens and prism for the appropriate section of the spectrum is effected automatically by turning a lever. The plate is shifted for successive exposures by means of a coarse pitch screw.

New Slow Combustion Pipette

(Burrell Technical Supply Co.)

THE slow combustion method is now generally employed in gas analysis for determining certain combustible constituents such as methane, ethane and hydrogen.

The conventional slow combustion pipette consists of a glass shell closed at the bottom with a rubber stopper through which are passed two glass tubes supporting a platinum ignition coil at the top. The glass tubes may be sealed at the bottom with platinum wire through the seal and the tubes filled with mercury to establish electrical contact with the coil. Or the tubes may be sealed at the top with wire running up through the length of the tube and out through the top seal with the ignition coil attached to the wire ends.

Either of these older types has a number of disadvantages. Should the coil burn out in the midst of an analysis the sample must be discarded, the pipette removed and repaired and a new sample started. The plain coil without support will sag and get out of line when heated and may fuse together and burn through easily should adjacent coils touch. The coil sometimes gets loose at the contacts necessitating removal of the pipette for repairs. Also the operator may unintentionally heat the coil to the fusing point at the start of the combustion by allowing too much unburned gas to accumulate in the top of the pipette.

The Burrell dual-ignition slow combustion pipette employs an outer shell of Pyrex glass with a single electrode through the bottom stopper supporting two ignition cartridges. The cartridges are placed about 1/16 inch apart and directly below the capillary opening. The ignition cartridges are novel and have proved highly efficient. The exact amount and size of platinum wire is wound on a small solid refractory rod. The wire passes through holes in the ends of the rod and is beaded against the rod at each end in the form of a small solid ball of platinum.

Three special metal wires pass up through the center electrode. These wires are sealed gas tight through the glass and are bent as shown to support the cartridges. One of the wires is common to both cartridges while the other two are on separate circuits. The cartridges are snapped in place and are tightly held by the spring action of the wire. The contact never gets overly hot due to the balls of platinum on the ends of the coil.

The circuit includes a small transformer for supplying low voltage current, a specially designed small rheostat for adjusting the temperature of the ignition coil and a three-way toggle switch.

To operate, the switch is thrown to the right or left whereupon one of the coils heats up. The temperature is adjusted by means of the rheostat and the combustion operation carried out as usual.

The refractory of the new Burrell dual-ignition slow combustion pipette gets hot and aids the combustion operation materially. It has also been found that the refractory absorbs any sudden surges of heat due to the flame reaching the coil. Ordinarily, the coil may burn through under such conditions.

The new Burrell dual-ignition slow combustion pipette can be installed on any type of gas analysis apparatus. It can be used either with water or mercury. The coils are supported in a fixed position and cannot sag or get out of line. Should one coil burn out in the midst of an analysis, the toggle switch is thrown to the opposite side and the other coil goes into action immediately. The sample is saved and the operator can replace the damaged coil at his convenience.

Spencer Lecture Table Delineascope

(Spencer Lens Company)

THIS new unique instrument more nearly fills the need of the lecture room than any other type of lantern. The slide lies horizontally on top of the Delineascope, exposed to permit pointing to any part of it. Objects in fluids in open glass dishes may be likewise projected.

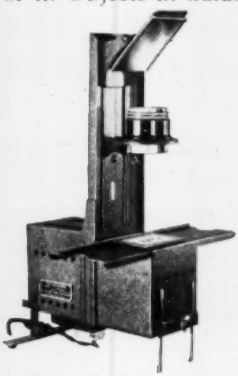


Fig. 1

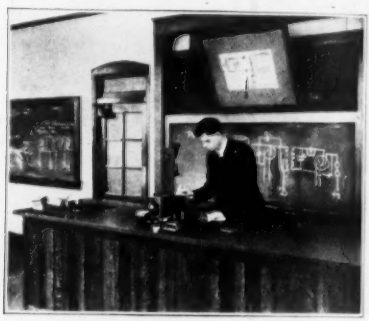


Fig. 2

The instrument is 14″ long by 5″ wide by 23″ high. The upright supporting the objective and the mirror above it arises 15″ above the body of the instrument. The lengthened base at the back of the instrument stabilizes the effect of the unusual height. The table on which the slide rests is long enough to hold three slides. The lamphouse is hinged at the back for the convenient exchange of bulbs. The instrument is equipped with a 500 watt, 115 volt monoplane filament bulb in precentered socket. There is a reflector back of the bulb. A mirror is placed between the condensing lenses to reflect the horizontal beam of light vertically through the slide objective, etc.

The projected picture illustrated in Figure 2 was made with an objective of 6½″ focus. The 5½″ objective will project a picture more nearly filling the screen at the same distance. Objectives up to 10″ focal length may be used on this instrument making it available for the great majority of projection requirements.

New Electric Time Switch

(R. W. Cramer & Company, Inc.)

THE illustration shows the ZMO type single throw self-winding time switch. The main switch is motor operated, double break, quick acting, laminated brush contacts with substantial arcing tips. The entire main switch operates in a bath of circuit-breaker-oil, to maintain long contact-life under these heavy loads. These contacts are guaranteed for constant load at rated capacity (per pole) plus 25% overload.

The electric motor is the same as used in all Sauter-time switches. It is of the series type, 115 230 volt, operating on any standard frequency or on direct current without adjustment, it being "Universal." Voltage drops of as much as 20% are without effect upon its dependability. The power consumption averages less than 20 watts while running and the total operating time is less than 3 minutes daily (less than ½ kwh. per annum). Each motor and its control circuit is tested to 2000 volts to ground for one minute.

The time movement is a self-winding clock with oversize precision-cut gears, polished steel pinions; heavy cold rolled hard brass clock-plates, paired by a process insuring perfect alignment and finish of the bearings; 11-jewel lever escapement (this entire unit being interchangeable in all Sauter self-winding clocks). Brequet hairspring, Invar metal balance wheel (unaffected by fluctuations in temperature); 4-day mainspring, rewound automatically by electric motor twice every 24 hours (to restore clock to exactly its "fully-wound" position); positive and simple mechanical release precluding all danger of over-winding.

When desired this clock can be furnished with the Sunday-cut-out; automatically causing the time switch to suspend its functions every seventh day.

The toggle switch control contact is operated by 24-hour dial; the contact being used only to close the electrical winding circuit, the opening of this 20-watt circuit being accomplished from position-control wiping-contacts on rotary main-switch-shaft. (Hence no possibility of reversal of "on" and "off" operations.)

A single 24-hour dial serves both for time setting and for program setting. Where it is desired to have the operations conform to a constant schedule the plain dial is recommended. For lighting circuits, on an all-night schedule, the astronomic dial is extremely valuable, as it automatically resets the daily operations to conform to local sun time (dusk or dawn or both).

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ELECTRICAL AND MAGNETIC MEASUREMENT

ELECTRICAL MEASURING INSTRUMENTS AND SUPPLY METERS. D. J. Bolton. 1923. Cloth, 344 pages, $6.00.

ELECTRICAL MEASUREMENTS IN PRACTICE. F. Farmer. 1917. Cloth, 360 pages, $4.50.

ELECTRICAL METERS. C. Jansky. 1917. Cloth, 416 pages, $4.00.

PROPERTIES AND TESTING OF MAGNETIC MATERIALS. Thomas Spooner. 1927. Cloth, 385 pages, $5.00.

MAGNETS. Charles Underhill. 1924. Cloth, 449 pages, $4.00.

ELECTRICAL MEASUREMENT. F. Laws. 1917. Cloth, 719 pages, $5.50.

ELECTRICAL MEASUREMENTS IN THEORY AND APPLICATION. A. Smith. 1924. Cloth, 338 pages, $3.00.

METHODS OF MEASURING ELECTRICAL RESISTANCE. E. Northrup. 1912. Cloth, 388 pages, $4.50.

CONNECTING AND TESTING DIRECT-CURRENT MACHINES. F. A. Annet and A. Rie. 1925. Cloth, 237 pages, $2.50.

CIRCUIT TROUBLES AND TESTING. T. Croft. 1924. Cloth, 224 pages, $2.50.

PRACTICAL USES OF THE WAVE METER IN WIRELESS TELEGRAPHY. J. Mauborgne. 1913. Cloth, 74 pages, $1.25.

ELECTRIC AND MAGNETIC MEASUREMENTS AND MEASURING INSTRUMENTS. F. W. Roller. 1907. Cloth, 398 pages, $3.50.

EXPERIMENTAL ELECTRICAL ENGINEERING & MANUAL FOR ELECTRICAL TESTING. V. Karapetoff. Vol. I. 1922. Cloth, 795 pages, $6.00. Vol. II. 1927. Cloth, 620 pages, $5.00.

ELECTRICITY METER PRACTICE. Solomon. 1923. Cloth, 189 pages, $3.50.

THE PRINCIPLES AND PRACTICE OF ELECTRICAL TESTING. R. G. Allen. 1919. Cloth, 365 pages, $6.50.

THE INSPECTION AND TESTING OF MATERIALS, APPARATUS AND LINES. F. I. Henley. 1923. Cloth, 355 pages, $7.00.

TESTING OF MOTIVE POWER ENGINES. R. Royds. 1920. Cloth, 392 pages, $7.50.

DIE TECHNIK ELEKTRISCHER MESSGERAETE. G. Keinath. 1928. Vol. I: Measuring Instruments & Accessories. Cloth, 620 pages, $10.00. Vol. II. Measuring Methods. Cloth, 424 pages, $7.00.

EMPFINDLICHE GALVANOMETER FUER GLEICH UND WECHSELSTROM. Otto Werner. 1928. Cloth, 208 pages. Price $5.00.

New DF-1 Level Flight and Altitude Indicator

(American Paulin System, Inc.)

A REMARKABLE instrument has been developed to meet a new standard of precision in aircraft altimeters. This is the Paulin level flight and altitude indicator, which enables the pilot to maintain level flight at accurately known altitudes (to which the indicator is set before leaving the ground) always.

Its development for the market followed such severe tests as those accorded by the flight to Australia by Kingsford-Smith; the blind flying in the record breaking coast-to-coast hop by Captain Hawks, and further demonstrations by such trial blazers as Parker Cramer.

It is claimed for this indicator that it brings into the field of aeronautics the same precise accuracy in the determination of altitudes, which engineers and surveyors have used to determine accurate—not approximate—elevations on the ground.

The aviator may "set" the recording instrument before leaving the ground, to the exact elevation at which he desires to fly. Through day fog or night blackness this indicator becomes the eyes of the ship. Visibility blanked, distances distorted or landmarks erased, the level flight and altitude indicator enables the flyer to proceed at regulation speed upon a predetermined level course.

So sensitively tuned that variances of less than 10 feet are indicated at a glance, this instrument is of special value to the military or professional air photographer. In aerial photography a given landscape is charted by flying over the scene in paralleling course several times. As developed the prints are trimmed and lapped to match up at the sides so as to complete a composite air-view of the topography.

The importance of accurate level flight in such work, to avoid distortion and to emphasize proportion of detail upon an equalized scale is of utmost importance. Now that the aviator may fly back and forth across the terrain with precision of altitude the pictures obtained should depict with precise accuracy the ground detail.

It establishes a new technique in aerial surveying and every ground contour is reproduced upon the identical scale. Entire States are being re-surveyed from the air. Wisconsin is one of the latest to undertake the work. And it is reported that they are finding unheard of lakes; islands which were lost, and inaccuracies in lake boundaries. Geologists and mining engineers are joining in the usages of the new device.

In the business of everyday flying where precise altitude information is an important factor, as in aerial mapping and cross country flying, exploration, etc., the Paulin level flight and altitude indicator is performing with consistent dependability and unerring accuracy.

The new instrument is most efficient, easy to read by day or night. It can be installed upon any plane on practically any instrument board. It is as valuable to the sports flier in his single seater, as to the operator of the major transport lines.

In daytime, when cloud banks lower the ceiling, or when storms demand a change of altitude, the Paulin instrument proves its outstanding importance in aerial navigation. Its extreme sensitiveness allows the pilot to drop down to a safe altitude for observation with full confidence that his altimeter is indicating that drop, foot by foot, without lag. It is the overcoming of this "lag" that has attracted the attention of the industry to this new indicator.

By actual test, a ship has demonstrated that it can dive 1,000 or 5,000 feet, level off, and find that the Paulin indicator steadies itself at the new elevation immediately, a performance not matched.

The luminous dials of the indicator at night becomes the "eyes of the ship." With visability blanked by a wall of darkness, distances distorted, landmarks erased, the Paulin level flight and altitude indicator guides the safety flier on a level course clear of all earthly obstructions, and along the lane of most favorable weather.

As the ship gains or loses a few feet in altitude, these variations are immediately indicated to the pilot. This immediate responsiveness is always dependable. With the compass as directional guide; and this instrument as an altitude guide, straight flying is assured.

The Paulin discovery as assembled for practical uses in this new instrument becomes a step of revelation in the rapidity of the advance in scientific development toward safety in flight.

The experimental era in aerial transportation is passing. That is admitted. Passenger, express and mail planes fly the airways day and night, linking cities, shattering time. Schedules demand departures on time. Rapid increase in passenger traffic calls for "trains" of planes over the same route, bound for the same destination. Regulation of traffic in the air is of vital importance. The right of way of the air-ways between two points must be laid in lanes finely determined by altitude to insure safety.

In darkness, storm or obscure weather, the Paulin level flight and altitude indicator is there to guide the pilot safely at a set altitude.

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HANDBOOK OF HYDRAULICS. H. King. 1929. Cloth, 420 pages, $3.50.
HYDROLOGY. D. Mead. 1919. Cloth 650 pages, $5.00.
STEAM GAGING. W. Liddell. 1927. Cloth, 239 pages, $3.00.
RIVER DISCHARGE. J. Hoyt & N. Grover. 1916. Cloth, 210 pages, $2.50.

ENGINE INDICATORS

MANUAL OF THE STEAM ENGINE INDICATOR. C. Peabody. 1900. Cloth, 153 pages, $1.50.
STEAM ENGINE INDICATOR. F. R. Low. 1910. Cloth, 169 pages, $2.00.

CALORIMETRY

THE EXAMINATION AND THERMAL VALUE FUEL: Gaseous, Liquid and Solid. J. Cost and E. Andrews. 1914. Cloth, 278 pages, $2.75.
THE MODERN CALORIMETER. W. P. White. 1928. Cloth, 194 pages, $4.00.

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AIR LOG. The Air Log or Distance Recorder shows the air distance traveled by the aircraft. This instrument is described in a leaflet of the Pioneer Instrument Co., 754 Lexington Ave., Brooklyn, N. Y.

ADDING MACHINES. Leaflet describes 3 styles of adding machines. Automatic Adding Machine Co., Inc., 63 West 24th St., New York, N. Y.

ALTIMETERS AND THE PAULIN SYSTEM LEVEL FLIGHT INDICATOR. This is the title of a reprint from the Airway Age. It describes and contrasts the function of ordinary altimeters and the Paulin type. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

ACCURACY AND EFFICIENCY PROGRESS TOGETHER is the title of a leaflet on balances manufactured by the Torsion Balance Co., 92 Reade St., New York, N. Y.

AIR SPEED INDICATOR. Leaflet describes the air speed indicator of the Pioneer Instrument Co., 754 Lexington Ave., Brooklyn, N. Y.

ARMATURE TESTER. This device is used for detecting shorts, open circuits, wrong connections, and grounds without unsoldering any of the leads from the commutator or disturbing the hoods. Century Electrical Co., Syracuse, N. Y.

BAROMETER. Leaflet illustrates several types of barometers. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

BARRELING METER. Bulletin Figure 766 illustrates and describes the Xacto Meter Barreling Unit. S. F. Bawser & Co., Fort Wayne, Ind.

BOILER BLOWOFF CONTROL. This leaflet discusses factors limiting safe concentration in boilers, and discusses the use of the Permutit Blowoff Hydrometer. Permutit Co., 440 Fourth Ave., New York, N. Y.

BATTERY METER PRICE LIST. Voltmeters and ammeters for radio and battery service stations are listed. Reliance Instrument Company, 1135 West Van Buren St., Chicago, Ill.

BRIDGE - MEG RESISTANCE TESTER. List No. 167 describes and illustrates this instrument. Evershed & Vignoles, Ltd., Chiswich, London, W 4, England.

CHEMIST ANALYST. The September 1st issue of the house organ contains interesting methods of analysis and construction of laboratory apparatus. J. T. Baker Chemical Co., Phillipsburg, N. J.

CONTROLS FOR REFRIGERATION EQUIPMENT. Catalog No. R-3 illustrates various applications of Mercoid controls. The Mercoid Corporation, 564 W. Adams Sa., Chicago, Ill.

COVERIMETER. This leaflet describes an instrument for measuring the covering power of paint by measurement of the thickness of the paint film producing a definite relative opacity. Adam Hilger, Ltd., 24 Rochester Pl., Camden Rd., London, N.W. 1, England.

COMPARATOR. Leaflet describes and illustrates the Tenthou Comparator or optical gauge. Adam Hilger, Ltd., 24 Rochester Pl., London, N.W. 1, England.

COMPASS. The purpose, construction and development of the Pioneer Compass is taken up in this leaflet. Pioneer Instrument Company, 754 Lexington Ave., Brooklyn, N. Y.

COUNTERS. A large number of counter types are illustrated in this bulletin. This literature is printed in English. Ludw. Loewe & Co., Berlin N.W. 87, Huttenstrasse, Germany.

CONSTANT PRESSURE CONSTANT-FLOW REGULATORS. Catalogue V-2 illustrates and describes this device. Brooke Engineering Co., Inc., 1321 Arch St., Philadelphia, Pa.

COMBUSTION CONTROL. Catalogue 5 illustrates an electrically actuated combustion control. Brooke Engineering Company, 1321 Arch St., Philadelphia, Pa.

CONDENSERS AND RESISTANCES. The following condensers: filter, bypass, mica, molded and equalizing; and resistances: tubular, strips metallized, volume controls and rheostats, are listed and illustrated in Catalog 2930. Polymet Manufacturing Corp., 829 East 134th St., New York, N. Y.

DYNAMOMETRIC IMPACT APPARATUS. Leaflet describes the dynamometric impact apparatus used to measure the resilience of metals. Steel City Testing Laboratory, 8843 Livernois Ave., Detroit, Mich.

ENGINEERING INSTRUMENTS. Bulletin 50 is a complete catalogue illustrating and describing the various Gurley products. Bulletin 75 covers in detail the Hell Gate Transit. Bulletin 130 covers Light Weight Transits. Bulletin 150 is devoted to Explorers Precise Transits. Bulletin 175 to a new Reconnoissance Transit. Bulletin 200 to Levels. Bulletin 300 to Compasses. Bulletin 400 to Topographic Instruments. Bulletin 500 to Rods. Bulletin 700 to Current Meters. Bulletin 100 to Field Accessories and Supplies. W. & L. E. Gurley, Troy, N. Y.

ENGINE INDICATORS. Leaflet 1262 gives information on Maihak indicators for speeds up to 2200 RPM and pressures up to 500 pounds. Leaflet 1263 covers the Maihak indicator for Diesel, Gas and Steam Engines, Ammonia Compressors and Pumps; Leaflet 1264 the Maihak indicator with power integrator. Bacharach Industrial Instrument Company, 7000 Bennett St., Pittsburgh, Pa.

ERICHSEN MACHINE FOR TESTING METAL STRIPS AND SHEETS. Bulletin discusses the testing of sheets and gives directions for using the machine. The Bock Machine Co., 3816 Colerain Ave., Cincinnati, Ohio.

ELECTRICAL INSTRUMENTS. Folder contains leaflets on various products of the Hoyt Electrical Instrument Works, 857 Boylston St., Boston, Mass.

ESTIMATION OF COLORING MATTER IN TANNING SOLUTIONS. Leaflet covers use of the Rosenhein Schuster Colorimeter. Tintometer, Ltd., 1 The Friary, Salisbury, England.

ELECTROCARDIOGRAPH. Bulletin describes the Sanborn Electrocardiograph. Sanborn Company, 26 Lansdown St., Cambridge, Mass.

FLUID METER. Bulletin Figure 764 gives information on the Xacto Meter; Bulletin Figures 767 and 768 on the one-quantity predetermined Xacto Meter. S. F. Bowser & Company, Fort Wayne, Ind.

FLIGHT TEST PROCEDURE. A bulletin issued by the Educational Division was written and compiled to simplify the work of test

pilots and engineers in determining aircraft performance. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

FIELD TESTER. Leaflet describes an electrical testing instrument designed for testing field coils and armatures of direct current types of motors and generators. Century Electrical Company, Syracuse, N. Y.

GENERAL RADIO EXPERIMENTER. The July-August issue of the Experimenter contains the following: The Importance of Mutual Conductance in Testing Vacuum Tubes; A Rectifier-Type Meter for Power Output Measurements at Audio Frequencies; and How and Why the Fader. General Radio Company, 30 State St., Cambridge, Mass.

GENERAL CATALOGUE OF BOILER ROOM INSTRUMENTS. Folder contains bulletins on CO_2 meters, draft gauges, portable combustion test tests. Hays Corporation, Michigan City, Ind.

GEAR TOOTH COMPARATOR. Leaflet describes the Sykes gear tooth comparator for measuring gear teeth as well as the wear of the teeth. Farrel-Birmingham Co., Inc., 344 Vulcan St., Buffalo, N. Y.

GRAPHIC INSTRUMENTS FOR THE CONTROL OF IMPORTANT PROCESSES. Bulletin 829 is devoted to the discussion of applications for controlling mixing processes: clay products, grinding processes, cement manufacture, etc. Esterline-Angus Company, Indianapolis, Ind.

GALVANIZING KETTLE PYROMETER. Leaflet is devoted to automatic controllers for holding bath temperatures. Circ. 115-P-6-929 Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

HIGH FREQUENCY STABILISATION BY PIEZO-ELECTRIC OSCILLATORS. This bulletin introduces the oscillator, its uses, method of application and particulars of the Hilger oscillator, etc. Adam Hilger, Ltd., 24 Rochester Pl., London, N.W. 1, England.

HOMO METHOD FOR PRODUCTION TEMPERING. Catalog 93 gives complete information on the Homo method—what it is and what it does. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

HARDNESS TESTING OF METALS. This booklet is a compendium of the possibilities and current practices with one type of tester. Wilson-Maeulen Company, Inc., 383 Concord Ave., New York, N. Y.

HARDNESS TESTING HAMMER. Leaflet gives description and instructions for use of a hardness testing hammer. Steel City Testing Laboratory, 8843 Livernois Ave., Detroit, Mich.

HOT BLAST TEMPERATURE CONTROL. Bulletin 372 gives information on a new automatic hot blast temperature control. Bristol Company, Waterbury, Conn.

HEAT TREATING EQUIPMENTS OF 1929. Direct mail piece lists the names of Homo furnace users. Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

INSTRUMENT INVESTMENT NEWS The September issue of the paper contains the following: Modern Buildings and Modern Gas Boards; The Cab of the 20th Century; Cost of Ice Making Depends on Recording Thermometers. Consolidated Ashcroft Hancock Co., Inc., Bridgeport, Conn.

INDICATING CALIPER. Leaflet describes an instrument for determining the accuracy of rolls. Farrel-Birmingham Co., Inc., 344 Vulcan St., Buffalo, N. Y.

LEVELING BY ALTIMETER. Article written by Sir Gordon Hearn for the Educational Division of The American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

LIMIT BRIDGES. Circ. 4270-G 35-929 covers a new limit bridge. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.

LABORATORY. Vol. 2, No. 4 of the Laboratory contains a story on Paracelsus, a founder of pharmacology, as well as descriptions of a number of instruments. Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.

METER PRICE LIST. This booklet is a water works meter price list. National Meter Company, 299 Broadway, New York, N. Y.

METER CONTROL. Bulletin 181 is devoted to automatic combustion control, in addition to information on the control it contains illustrated descriptions of installations. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

MODERN MINE VENTILATION AND THE USE OF THE ALTIMETER. A reprint from the Mining Congress Journal, which covers economical ventilation determined by the proper selection of equipment and system design. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

MEASURING MICROMETERS. Bulletin contains descriptions of the following: Measuring Micrometer with 6" travel; Photomeasuring micrometer and the Guild Spherometer. Adam Hilger, Ltd., 24 Rochester Pl., London, N.W. 1, England.

MEASUREMENT OF THE METER IN WAVELENGTHS OF LIGHT. Bulletin describes the apparatus of Benoit, Fabry and Perot. Adam Hilger, Ltd., 24 Rochester Pl., London, N.W. 1, England.

MICROMETER. Leaflet illustrates a 0 to 4" micrometer by thousandths of an inch. Brown & Sharpe, Providence, R. I.

MEGGER EARTH TESTER. Bulletin No. 163a discusses earth testing and describes the Megger earth tester. Evershed & Vignoles, Ltd., Chiswick, London, W. 4, England.

MICROMETERS. Catalog 7 lists various micrometers manufactured by Reed Small Tool Works. Worcester, Mass.

MEASURED PERFORMANCE THE FIRST STEP IN COST CONTROL. Reprints of advertisements appearing in trade publications. General Electric Company, Schenectady, N. Y.

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*Title*_____

OPTICAL GAUGES. Leaflet describes and illustrates optical system for gauging specimens. Adam Hilger, Ltd., 75a Camden Rd., London, N.W. 1, England.

OIL METERS. Circular 110 covers Empire oil meters for the measurement of oil meters, gasoline and other distillates of petroleum. National Meter Co., 299 Broadway, New York, N. Y.

PARKS' PARABLES. The September issue is devoted to a discussion of Humidity in the Knitting Mill. Parks-Cramer Company, Fitchburg, Mass.

POWER PLANT EQUIPMENT-INSTRUMENTS. Catalogue j-29 gives detailed information on the items sold by Paul B. Huyette Co., Inc., Philadelphia, Pa.

PRECISION ALTIMETER AND LEVEL FLIGHT INDICATOR AS A SAFETY GUIDE IN FLYING AND LANDING. Booklet gives a description and discusses the use of the Paulin System aerial altimeter and level flight indicator. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

PRELIMINARY SURVEY PROCEDURE. Booklet explains in detail the practical use of the altimeter in connection with all branches of preliminary field surveying. American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

POCKET PYROMETER. Prospekt Nr. 262 describes a new pocket optical pyrometer having a measuring range of 900-1900 deg. C. This leaflet is printed in German. Strochlein & Co., Duesseldorf 39, Germany.

PORTABLE MEGOHMMETERS. Bulletin 521 describes a portable megahmmeter manufactured by the Illinois Testing Laboratories, Inc., 143 W. Austin Ave., Chicago, Ill.

POTENTIOMETER RECORDING PYROMETER. Catalog Section P-1929 describes the new potentiometer recording pyrometer. Wilson-Maeulen Company, Inc., 387 Concord Ave., New York, N. Y.

PYROMETER CHECKING AND CALIBRATING SET. Leaflet F97 illustrates a potentiometer for checking all types and makes of pyrometers. Thwing Instrument Company, 3339 Lancaster Ave., Philadelphia, Pa.

REVOLUTION CONTROLLER AND STOP COUNTER. Leaflet covers controls for stopping a machine at any predetermined production figure. Viking Tool & Machine Co., Inc., Brooklyn, N. Y.

ROTAMETER FOR GASES AND LIQUIDS. Leaflet illustrates the various types of Rotameters. This literature is printed in German. Deutsche Rotawerke, G.m.b.H., Aachen, Germany.

ROUND FORM RECORDERS. Leaflet illustrates new round form recorder. C. J. Tagliabue Mfg. Co., 18 Thirty-third St., Brooklyn, N. Y.

RECORDING PSYCHROMETERS. Bulletin discusses humidity and describes the self-contained type recording psychrometers. A relative humidity table is also included. Bristol Company, Waterbury, Conn.

RATCHET STROKE OR REVOLUTION COUNTER. Leaflets describe and illustrate several types. J. Hengstler, Aldingen near Spaichingen, Germany.

REFRACTORIES. Catalog No. 141 covers the manufacture of the bricks, gives the sizes and shapes, tables for calculating the number of bricks necessary, mortars and bonding materials, etc. Denver Fire Clay Co., Denver, Colo.

SPECTROMETER. Prospekt Nr. 19 illustrates the large Universal spectrometer type 10 for precision measurements. Seemann Laboratorium, Freiburg, Rheinstr. 4, Germany.

SCIENTIFIC LABORATORY AND POWER PLANT EQUIPMENT. Bulletin 14 gives information on the Ac-me 100" water column, recording gravitometer, specific gravity gas balance, etc. Refinery Supply Co., 621 E. Fourth St., Tulsa, Okla.

SOFTENED WATER THE UNIVERSAL NEED. Bulletin describes rapid rate upflow zeolite softener. Paige & Jones Chemical Co., Inc., Hammond, Ind.

STRAIN VIEWER. Bulletin illustrates and describes the glass strain-viewer for bottles, jars, tubes, glassware, sheet, lamp chimneys, etc. Adam Hilger, Ltd., 24 Rochester Pl., London, N.W. 1, England.

SPECTROPHOTOMETERS, COLORIMETERS AND APPARATUS FOR SENSITOMETRY. This bulletin gives information on the following: spectrophotometers for the Ultra-Violet, Visible, Infra-Red and for photographic plate and filter testing, the Wedge spectrograph for color sensitivity, apparatus for measuring the intensity of spectrum lines and for investigating color perception, colorimeters. Adam Hilger, Ltd., 24 Rochester Pl., London, N.W. 1, England.

STEAM PRESSURE REGULATOR. Bulletin S2 illustrates the Brooke steam pressure regulator. Brooke Engineering Company, 1011 Harrison Bldg., Philadelphia, Pa.

SOME NOTES ON THE STROBOSCOPE. Booklet gives considerable information on stroboscopes, as well as on the Ashdown Rotoscope. Price 1 shilling 6 pence. A. J. Ashdown, Ltd., 119 Victoria St., London, S.W. 1, England.

SAFETY SWITCHES. Catalogue 282 gives the distinctive features and detailed data on all classes and kinds of safety switches, motor starting switches, cutouts, linestatters, meter service switches, etc. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

SHEET METAL TESTER. Leaflet gives description and directions for operation. Steel City Testing Laboratory, 8843 Livernois Ave., Detroit, Mich.

SPECTROGRAPHIC ANALYSIS APPARATUS. Apparatus for Barratt's quantitative method of spectrum analysis is described in this leaflet. Adam Hilger, Ltd., 24 Rochester Pl., London, N.W. 1, England.

TITRATION SET. Leaflet describes the C.I.C. titration set for the measurement of chlorides in nickel plating solutions. Walter S. Wood Co., 15 Wharf St., Boston, Mass.

THERMO-COUPLE AMMETERS AND MILLI-AMMETERS. Bulletin 810 covers thermo-couple ammeters and milli-ammeters for use on direct current and on alternating current of any frequency including radio frequency. Roller-Smith Co., 233 Broadway, New York, N. Y.

TORSIOGRAPH. Leaflet gives a few facts which demonstrate the importance of the torsiograph. Lehmann & Michels, Hamburg-Altona, Germany.

TESTING OUTFIT FOR PRECISION WORK. Reprint from Machinery describing the use of optical flats for testing for flatness and parallelism. Adam Hilger, Ltd., 24 Rochester Pl., London, N.W. 1, England.

TRANSITS AND LEVELS. Bulletin 2 gives special features of the instruments. Leupold, Voelpel & Co., Portland, Ore.

MICROAMPEREMETERS. Leaflet gives details of microamperemeters. Sensitive Research Instrument Corp., 142 East 32 Street, New York, N. Y.

ORIFICE METER. Leaflet gives details on the Anubis differential pressure recorders. Natural Gas Equipment, Inc., Petroleum Securities Bldg., Los Angeles, Calif.

ORIGIN AND DEVELOPMENT OF THE BAROMETER AND ALTIMETER. Eight-page leaflet covers the following: Aristotle's Theory; Torricelli invents mercury barometer; Air pump awakens interest; Origin of the Aneroid; Deficiencies of the metallic barometer; Sources of errors in aneroids; Details of Paulin construction. American Paulin System, Inc., 1220 Maple St., Los Angeles, Calif.

PLANIMETERS AND PANTOGRAPHS. Price lists 302 and 402 give information on the various forms of planimeters and pantographs. A. Ott, Kempten-Allgaeu, Germany. This 40-page booklet is printed in English.

PHYSICAL TESTING MACHINES. This folder illustrates the various testing machines manufactured by Losenhausenwerk, Duesseldorf, Germany. This leaflet is printed in English.

POWER PLANT INSTRUMENTS. Bulletin No. 115-2 covers the following instruments: Recording gauges and thermometers, steam, liquid, air and gas flow meters, boiler water level recorder, recording liquid level gauge, draft gauges, CO_2 recorders, and controllers. Foxboro Co., Foxboro, Mass.

PRECISION INSTRUMENTS. Section I, catalog 1929, gives a brief introduction to the American Paulin System, Inc., 1220 Maple Ave., Los Angeles, Calif.

PRICE LIST—CHEMICALS. Price list dated August 1st issued by J. T. Baker Chemical Company, Phillipsburg, N. J.

SHIELDED RATIO BRIDGE. Circ. 1552-60-11-25 illustrates a shielded ratio bridge. Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa.

SPERRYSCOPE. Vol. 5, No. 12 issue contains the following articles: Learning their Gyros; Searchlights Aid River Navigation; World's Magnetic Forces One of Nature's Most Baffling Mysteries; Metal Mike Appears in Holland. Sperry Gyroscope Co., Brooklyn, N. Y.

STUDYING COSTS—WITH GRAPHIC INSTRUMENTS. Leaflet discusses cost study on motor driven machine tools, mining machinery and on heavy equipment. Esterline-Angus Company, Indianapolis, Ind.

TEMPERATURE MEASURING INSTRUMENTS. Bulletin 520 illustrates temperature measuring instruments for many purposes. Illinois Testing Laboratories, 143 W. Austin Ave., Chicago, Ill.

VACUUM PUMP. Leaflet describes and gives the advantages of the Holweck vacuum pump. Adam Hilger, Ltd., 24 Rochester Pl., London, N.W. 1, England

WIRE MEASURING MACHINE. Leaflet illustrates a machine designed to measure number of feet or yards of wire, cable, rope, cloth, etc. Viking Tool & Machine Co., Inc., Brooklyn, N. Y.

WATER METERS. Bulletin describes the Empire water meter, a positive displacement oscillating piston meter. Another bulletin describes the Nash disc water meter. National Meter Co., 299 Broadway, New York, N. Y.

WARM AIR FURNACE CONTROL. Bulletin 883 describes a warm air furnace control employing a thermostatic metal coil. Minneapolis Corporation, 564 West Adams St., Chicago, Ill.

WHEEL AND AXLE ALIGNMENT MANUAL. This booklet is a guide and instruction book and shows the application of tools and methods employed for making adjustments and repairs. Price $1.00. Bear Mfg. Co., Rock Island, Ill.

WATCH YOUR SAND. This is the title of a leaflet, which describes the Universal Sand Tester for field use. Kolesch & Co., 138 Fulton St., New York, N. Y.

WATER WORKS JOURNAL. The September issue of this periodical contains the following: History of the Marshalltown, Iowa, Water Works; History of the Water Supply for Leominster, Mass., 1879 to 1929; Some Facts About the Water Department of the City of Lincoln, Neb. Pittsburgh Equitable Meter Co., 400 Lexington Ave., Pittsburgh, Pa.

WIRE GAUGE SELECTORS. Leaflet illustrates a small device which makes wire gauging easier. Brown & Sharpe Mfg. Co., Providence, R. I.

WATER LEVEL RECORDERS. Bulletin 4 gives information on the Stevens level recorder, Type E. Bulletin 9—Stevens long distance water level recorders and indicators. Bulletin 12—Stevens water level recorder type A. Bulletin 14—water level recorder type L, and Bulletin 15—the Stevens long distance water level recorders and indicators, position motor type.

X-RAY IN INDUSTRY. Booklet discusses the practical use of the X-ray in industry.

X-RAY EXAMINATION. Catalogue 529 supplies information on the apparatus for the X-ray examination of space lattice structure and the crystal orientation. Adlanco Ind. Products Corp., 54 Lafayette St., New York, N. Y.

X-RAY SPECTROSCOPY. This booklet gives information on this interesting subject. The booklet is printed in German. Adlanco Industrial Products Corp., 54 Lafayette St., New York, N. Y.

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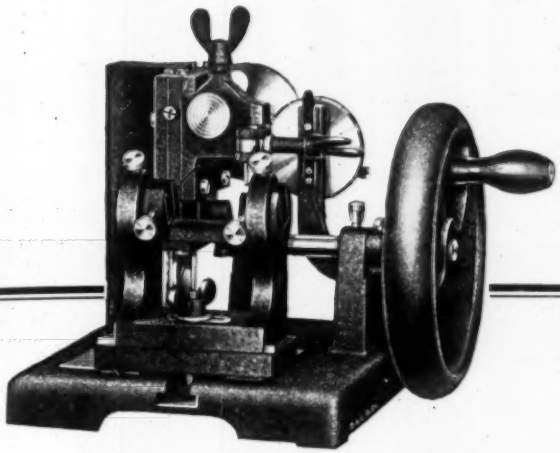

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INSTRUMENTS BOOK SHELF

The books reviewed in this section can be supplied by Instruments Book Shelf, Instruments Publishing Company, Pittsburgh, Pa.

STANDARDS AND STANDARDIZATION. *Norman F. Harriman.* McGraw Hill Book Co., Inc., New York, N. Y. First Edition, 1929. 265 pages, 1[illegible] figs. Price $3.00 Postpaid.

REVIEWED BY W. H. BOYNTON

The author states that the purpose of this book is to present a concise account of the more important elements of the science of Standards and Standardization. The subject work is divided into nine chapters and an appendix. By way of introduction, the evolution of standards, industry, and standardization from the origin of standards in earliest times to recent developments as exemplified in the enormous consolidations in the business world are dealt with. Two chapters are devoted to standards, their purposes, kinds of units, and the importance of maintaining them. Standardization is the main theme of the book. Features of general and of particular considerations in connection with standardization are indicated in a concise and accurate manner. Strict attention is given to scientific, technical and economic accuracy. Quality of standardization and specification writing are discussed with emphasis given to the necessity of making specifications as simple, precise, yet as flexible as possible without impairing their utility. National standardizing bodies and their functioning, and International and National Standardizing Laboratories are described. The general need of standardization is indicated. A chapter is devoted to Standardization and Coordination of Government Purchases, and some of the work of extreme accuracy of measurements conducted at the United States Bureau of Standards and the instruments used are outlined. The book is well written, is concise, and is remarkably free from typographical errors. It contains a splendid bibliography and should be valuable to purchasing agents, technical directors and others responsible for the establishments of standards. The book is included in the McGraw-Hill Industrial Management Series.

A MANUAL OF FIRE ASSAYING. *Charles Herman Fulton and William J. Sharwood.* McGraw Hill Book Co., Inc., New York, N. Y. 268 pages, 59 figs., 58 tables. Third Edition. Price $3.00 Postpaid.

REVIEWED BY W. H. BOYNTON

This edition, in which Dr. Sharwood has joined Prof. Fulton in co-authorship, is thoroughly revised, in part rewritten, and contains considerable new material. In particular this applies to the chapters on "Assay Furnaces and Tools," "Reagents," "Parting and Inquartation," and "The Assay of Platinum and Related Metals." Considerable detail is devoted to various types of assay balances, their principles and functioning. Several changes are noted in melting points, such as litharge 884° C. instead of 904° C., $CaCO_3$ begins to give off CO_2 at 800° C. instead of 7[illegible] C. Magnesia cupels consisting of about 90% MgO and 10% impurities are receiving more and more attention. Analyses of several of these Patent or Magnesia cupels and cupels material are given. Portland cement cupels are satisfactory only when the mixing water is carefully measured. Cupellation in different types of cupel materials is outlined. The typography and spacing in this edition are improved. The book is well written and is an excellent text book for the student of assaying and for the commercial assayer.

ROENTGENOGRAPHIE DES EISENS UND SEINER LEGIERUNGEN. *C. Neuburger.* Ferdinand Enke, Stuttgart, 1928. Paper, 6½ x 10, 124 pages. Price 3.75 RM.

REVIEWED BY RICHARD RIMBACH

Of the different books treating investigations of metallic materials by means of X-rays the present volume is one of the outstanding as it is confined solely to iron and its alloys. The results of the numerous tests are clearly tabulated and the results of the author's own observations have also been included. In the introduction, the methods of metal and alloy research and the structure of solid solutions are discussed; a chapter is devoted to allotrophy of iron. Further, the behavior of the allotropic modifications of the iron towards carbon and the other alloying constituents is discussed in detail. The tabulation of the data on crystal lattices is especially important. The work is concluded with a bibliographic index in this field. This book can be recommended to every metallurgist.

DIE WAERMEBILANZ DES DIESELMOTORS. Messtechnische Probleme. *A. Stauss.* Verlag von Wilhelm Knapp, Halle, 1929. Paper, 72 pages, 6 x 9. Price 2 RM.

REVIEWED BY MAX HARTENHEIM

The author points out that practically all heat balances of internal combustion engines published heretofore are wrong. The heat in the cooling water of the engine, caused by piston friction is not deducted, which causes this member of the equation to be too high. The various methods for the determination of the fuel used are given and the difference in the heat value determined in the bomb calorimeter as compared with the Junker calorimeter is discussed.

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CURRENT LITERATURE REVIEW

Abstracts on instruments and devices for measurement, inspection and control.

The Technology Department, Carnegie Library, Pittsburgh, Pa., will furnish photostats of material abstracted here. Negative prints are 35 cents per page, plus 10 cents for mailing (first class). All orders should be paid in advance. The library is not responsible for loss in mails.

Contribution to the Methods of Fluorescence Analysis (Beitrag zur Methodik der Fluorescenzanlyse). M. Hattinger and V. Reich. Chemische Fabrik, August 21, 1929, pp. 379-380.

Description of an arrangement by means of which the ultraviolet rays fall vertically upon the surface of liquids. By lateral observations one recognizes the pure fluorescent colors and the depth of penetration of the exciting rays, thus permitting conclusions in regard to solution concentration. By the introduction of a water-lense the intensity of fluorescence can be increased. EF.

A New Method for Measuring Inner Threads (Ein neues Verfahren zum Messen von Innengewinden). A. Haertel. Zs. Instrument. June 1929, pp. 301-304.

Difficulties encountered in these measurements are discussed. The improved method is chiefly based on the making of a cast copy the outer thread of which can then be easily measured. Tests have proved most successfully with copper amalgams. The new apparatus is fully described. EF.

Practical Construction of a Resistance Thermometer (Eine zweckmaessige Bauart von Widerstandsthermometern). R. Sewig. Zs. Instrument. June 1929, pp. 305-306.

The author calls attention to the influence of temperature fluctuations and proposes a new arrangement. EF.

Practical Gas Temperature Measure. George V. Slottman. Blast Fce. & St. Plt., Sept. 1929, pp. 1344-1345.

Points out the errors to be made in determining the temperature of a hot gas by the usual use of thermo-couple, due to radiation to or from the couple itself. Discusses the high velocity couple of Haslam and Chappell, and Wenzl and Schwarz, and the Schmidt method of heating or cooling the thermo-couple tip, for the accurate determination of gas temperature under these conditions. Cites some results of the application of the Haslam and Chappell high velocity couple to regular plant tests.—M.S.

Interpretation of Stack Gas Analysis. Pt. 2, G. E. Salkvist. Blast Fce. & St. Plt., Aug. 1929, pp. 1226-1229.

Continuation of article published in July 1929, pp. 1055-1057. Outlines methods applicable to the various types of fuels.—M.S.

Control for Continuous Furnaces. H. W. Moss and P. S. Austen. Heat Treating & Forging, Sept. 1929, pp. 1201-1204, 1211.

Discusses automatic temperature control equipment and discusses two typical installations. The controller consists of a pyrometer equipped with auxiliary contacting devices for operating an electric circuit which may be connected to control the heating medium.—M.S.

Portable Detector Developed for Many Combustible Gases. J. K. Mabbs and W. B. Rowland. Chem. Met. Engg., Aug. 1929, pp. 490-492.

The Union Carbide and Carbon Research Laboratories had developed an electrical indicating detector invented by A. N. Ericson. The instrument makes use of a heated metallic filament connected in one arm of a Wheatstone bridge circuit. Its use is based upon the fact that the temperature of the filament is increased by the burning of the gas on its surface, thus increasing its resistance. It was found to work satisfactorily with many gases, but it is not applicable for the detection of hydrogen, acetylene, or carbon disulphid in air. The industrial type consists of a combustion chamber with a 50 foot cable, a meter case housing the rest of the bridge circuit, the scale being suitably calibrated, and a storage battery. It is capable of determining a minimum concentration of about 2% of the lower limit of flammability.—M.S.

Comparative Indication of Flow Through Systems. Fred Enmarr. Chem. Met. Engg., Aug. 1929, p. 498.

Describes a very simple method for deriving the flows of fluids through various lines by means of home-made Pitot tubes and U-gages. If the lines are alike in size and arrangement, the deflection of the U-gage gives direct indication of the actual flow.—M.S.

The Electrical Transmission at a Distance of Meter Readings and the Taeuber-Gretler Induction System (La Transmission Électrique a Distance des Indications de Mesures et le Systeme a Induction Taeuber-Gretler). A. Imhof. Rev. Gen. de L'Electricite, Aug. 10, 1929, pp. 217-222.

Reviews briefly the characteristics of the principal systems which have been recommended and tried. Describes next the induction system devised by A. Taeuber-Gretler, enumerating the causes of errors and their elimination, and finally deals with the various applications of the system.—M.S.

Pocket Device Measures Height of Pole. Electrical World, Sept. 7, 1929, p. 501.

The W. N. Matthews Corp., St. Louis, Mo. has developed the type C. W. Matthews "Teleheight." To find the height of object A one stands away from the object until the bubble in the level part of the instrument and the line in the "Teleheight" cross each other. The distance from the object and the height of the eyes from the ground are measured. The sum equals the height of the object.—W.H.B.

(Current Literature Review continued on Page 22)

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On the Barometric Scale (Ueber die barometrische Hoehenskale). H. Ebert. Zs. Instrument, August 1929, pp. 407-414.

The physical-meteorological factors influencing the air-pressure are discussed, the computed height values are discussed. The new bulletin of the Physikalisch-Technische Reichsanstalt concerning the height-scale on aneroid-barometers is reproduced. The formula, which led to these specifications, are derived and compated with those of the Bureau of Standards. EF.

Protection of Microscopic Specimens Against Detrimental Effects of Heat Rays (Schutz der microskopischen Praeparate gegen die schaedliche Wirkung der Waermestrahlen). St. P. Kisfaludy. Zs. Instrument, August 1929, pp. 414-415.

In spite of the cooling effect of introduced water filters the glue of the preparations melts thus rendering the image achromatic. The new device consists of a 16 milli-micron gold film which is precipitated on the lense. This film reflects the heat-rays having at the same time a permeability of light of 73 per cent referred to the green mercury line of 546 milli-microns wave-length. The water filter is not necessary in the new arrangement. EF.

Elektro-Magnet-Lamp (Elektromagnetlampe). A. Salmony. Chemische Fabrik, April 3, 1929, pp. 159-160.

The smallest portable machine, used as an incandescent lamp of 2½ Volts, is described and illustrated. The lamp, the continuous rating of which is emphasized, obtains its energy from electromagnets driven by a clock-mechanism. Weight: 1200 gms., length: 20 cm. EF.

Apparatus for Combined Determination of the Benzene and Benzole Content of Air (Ein Apparat zur kombinierten Bestimmung des Benzins bezw. des Benzolgehaltes der Luft). P. Andrejew. Chemische Fabrik, March 27, 1929, pp. 147-148.

The apparatus described aims at the determination of the hydrocarbon content of air with sufficient accuracy, at the same time saving the hydrocarbons in almost unchanged state for qualitative (and eventually quantitative) analysis of their physico-chemical properties. The design of the apparatus permits the combination of the condensation and absorption method. EF.

New Apparatus for Water Determination with Difficult Inflammable Heat Carriers (Ein neuer Apparat zur Wasserbestimmung mitels schwer entzuendlicher Waermeuebertraeger). F. Friedrichs. Chemiker Zeitung, April 10, 1929, p. 287.

Xylole is replaced by tetra-chlor-ethane and the necessary modifications involved in the new apparatus are described. EF.

Apparatus for the Indication of Escape in Adsorption Plants (Apparat zur Bestimmung des Durchbruchs von Adsorptionsanlagen). A. Machert. Chemischer Zeitung, March 20, 1929, p. 228.

The new instrument which is designed to prevent losses due to over-loaded absorption establishments contains an automatic device which produces a short circuit as soon as the passing gases are not free from the constituent which should be absorbed. EF.

A New Melting Point Apparatus (Ein neuer Schmelzpunktapparat). Dr. F. Kerckow. Chemiker Zeitung, March 16, 1929, pp. 219-220.

The inaccuracy in former measurements due to the uncertain temperature of the thermometer thread center is avoided by placing it into a tube. This is passed by an air current which is uniformly heated by electric resistance wires. EF.

The Fulgurator as an Atomizer of Salt Solutions for Flame Spectra and the Photography of the Spectrum (Der Fulgurator als Zerstaeuber von Salzloesungen fuer Flammenspektren und die Photographie des Funkenspektrums). W. Hirschel. Chemiker Zeitung, March 16, 1929, pp. 218-219.

The spark spectrum of small quantities of solutions (0.1-0.5 ccm) can be examined without losing any substance by means of the new apparatus described in the paper. EF.

On Some Errors and Their Avoidance in Determining the Dropping-Point According to Ubbelohde (Ueber einige Fehlerquellen bei der Bestimmung des Tropfpunktes nach Ubbelohde und deren Vermeidung). E. Neumann. Chemische Fabrik, March 20, 1929, pp. 136-138.

The faulty dimensioning of the glass nozzle is pointed out to be the source of error encountered in the determination of the dropping point according to the standard Ubbelohde test. The application of a brass nozzle is proposed the dimensions of which are given in the paper. EF.

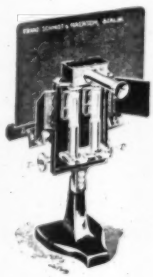
Some Improvements of Gas Analytic Apparatus (Einige Verbesserungen an gasanalytischen Apparaten). Dr. H. A. Bahr. Chemische Fabrik, January 9, 1929, pp. 13-15.

Some disadvantages of the gas adsorption pipettes are describes and practically tested changes are outlined. The modified Orsat model for gas analysis including the determination of hydrogen and methane is represented allowing a careful, complete analysis within 20 minutes with an accuracy of 0.1-0.2%. EF.

An Up-to-Date Refractometer for the Shop (Ueber ein modernes Betriebs Refraktometer). W. Ewald. Chemische Fabrik, March 20, 1929, pp. 133-135.

Anticipating the importance of the refractometric measurement for controlling purity and concentration of reagents, the author discusses in details the handy "Universal-refractometer of the Askania Works" applicable for many special purposes. The author concludes with a discussion on the accuracy and applicability of the refractometric measurement. EF.

(Current Literature Review continued on Page 24)



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How Pipe Line Companies Measure Gas. D. A. Sillers. Oil and Gas Journal, August 29, 1929, p. T-136.

The measurement of gas is briefly covered. The tin meter and proportional meter are mentioned. The present method of measurement is by means of the orifice meter. M. B.-F.

Fatigue Testing of Sheet Metals. J. R. Townsend and C. H. Greenwald. Metal Stampings, August 1929, pp. 599-600.

Abstract of paper presented before American Society for Testing Materials. Describes the machine developed and testing procedure. Material investigated consists of five alloys of alpha brass, and one each of nickel-silver, phosphor-bronze, and Everdur. Photomicrographs indicate that fatigue failure of these metals is transcrystalline. The results show that the ratio of endurance limit to tensile strength varies from 0.14 to 0.36 whereas for steels it ranges from 0.35 to 0.67, averaging about 0.40. Cold work raises the endurance limit but not proportionately to the increase in tensile strength produced by the same means. Material hardened by cold work shows a progressive decrease in ratio of endurance limit to tensile strength. M. S.

Recording Pressure Gage with Permanent Adjustment (Manometre enregistreur a controle permanant). R. Guillery. Revue de Metallurgie, June 1929, pp. 329-333.

Description of a recording pressure gage in which the piston is replaced with a ball. J. D. G.

A Simple Apparatus for Immediate and Direct Reading-Off of Corrosion of Metals, of Formation of Incrustation and of the Oxidation Power of Solutions (Eine einfache Apparatur zur sofortigen und direkten Ablesung der Korrosion von Metallen, der Inkrustationsbildung, sowie der oxydierenden Kraft von Loesungen, Osydimeter nach Toedt). Dr. L. Koehler. Chemiker Zeitung, July 20, 1929, p. 567.

Previous methods: gravimetric; new method; measurement of currents: Connecting a rare metal with the metal which is to be investigated and which can have any size, in the corroding medium (liquid), the current produced by this galvanic element is measured and converted into loss of weight by the law of Faraday. The relation discussed. The equipment which gives corrosion directly in gm/ day and m^2, is illustrated and its advantages given. E. F.

Construction of a Large Electro-Magnet (Ueber den Bau eines grossen Elektromagneten). A. Glaser. Physikalische Zeitschrift, August 1, 1929, pp. 472-477.

The construction of an electro-magnet in the University of Munich with magnetic field of 50,000 Gauss at a distance of 1 mm is described.

New Gas Storage and Gas Measurement Apparatus (Neues Gassammel und Gasmessgeraet). B. Kunisch. Die Chemische Fabrik, August 14, 1929, pp. 372-373.

Instead of pneumatic troughs a bottle with a ground in stopper and a side tube is used. The apparatus and its operation is described and the advantages are briefly summed up. E. F.

Nomography (Nomographie—Nommogramme fuer die Praxis der chemischen Fabrik). O. Liesche. Die Chemische Fabrik, August 14, 1929, pp. 373-374.

Reduction of measurements concerning the specific gravity to 20°C is adopted more and more. The reduction formula for pycnometers is given by: $d\frac{20}{4} = \frac{m}{w} \times 0.99703 + 0.00120$, wherein w = water value of the pycnometer and m = weight of the liquid which is to be determined. The troublesome computing of the factor $d\frac{20}{4}$ is avoided by a reproduced monogram. The equation for checking of a correction which has to be subtracted from $\frac{m}{w}$ is given and the whole calculation is illustrated by an example. E. F.

A Nitrometer Without a Hose for Half-Microchemical Work (Ueber ein schlauchloses Nitrometer fuer halbmikrochemische Arbeitsweise). E. Berl, K. Hofmann and R. Baumann. Die Chemische Fabrik, August 7, 1929, pp. 359-360.

Difficulties encountered in the old nitrometer of Lunge led to a modified instrument without rubber hose and which needs only relatively small amounts of mercury. The new apparatus is explained by means of five figures and the single steps of its running as filling of the burette, weighing in of substance of analysis, transferring of the dissolved substance into the burette, generating of NO, and pressure compensation are outlined in detail and the analytical results of two practical determinations are given. E. F.

Making the Glass Disk for a 70-Inch Telescope Reflector. A. N. Finn. B. of S. Jl. of Res., August 1929, pp. 315-329.

Details are given of the procedure followed in making a glass disk 70 inches in diameter and 11 inches thick for use as a reflector in an astronomical telescope. These include the making of the pots, the modifications in the construction of the melting furnace, the construction of the mold and annealing furnace, the methods of measuring and controlling temperatures, the melting and casting of the glass, essential data on annealing the glass, the determination of the quality of annealing (the amount and distribution of the residual strain), and the drilling of the hole to accommodate a Cassegrainian mounting.

(Current Literature Review continued on Page 25)

Detection of Starch, Glue and Casein in and upon Paper. T. C. Bentzen. Paper Trade Jl., June 6, 1929, p. 59.

Directions for the preparation of reagents and analytical procedure are given.—Abs. Bull. Kodak Res. Labs.

Microscopical Analysis of Paper. K. P. Geohegan. Paper Trade Jl., June 6, 1929, pp. 63-65.

Fiber determination and qualitative analysis by means of the microscope of materials used as fillers are the subject of this paper.—Abs. Bull. Kodak Res. Labs.

Oil Spot Photometer. M. Rancurel. Photo-Revue, June 15, 1929, pp. 183-184.

Opinions are given concerning the scale for a photometer which could be used for measuring photographic densities.—Abs. Bull. Kodak Res. Labs.

Vacuum Bolometer as Used in Measurements of Solar Radiation. N. Fairclough. Phil. Mag., June 1929, pp. 1067-1080.

For bolometer tapes of fixed width and length, there will be an optimum thickness which makes the instrument most sensitive. An attempt is made to find what thickness of tape would be best for measurements of solar radiation. For the particular conditions considered, it is found that the best tape to use is one whose thickness is between 11.5 by 10^{-5} cms. and 12.5 by 10^{-5} cms.—Abs. Bull. Kodak Res. Labs.

Review of the Most Important Measuring Chambers for Photogrammetric Snapshots from Aircrafts (Uebersicht ueber die wichtigsten Messkammern zu photogrammetrischen Aufnahmen aus Luftfahrzeugen). P. Werkmeister. Zs. Instrument. June 1929, pp. 306-307.

The author briefly describes the apparatus for taking photographs from the air built by the following companies: C. Zeiss-Jena, Aerotopograph-Dresden and H. Wild-Heerbrugg. EF.

The New Seconds-Measurer of the Siemens and Halske Works (Der neue Sekundenmesser der Siemens und Halske A. G.). W. Jaekel. Zeitschrift fuer Instrumentenkunde, June 1929, pp. 309-310.

The new instrument eliminates the inaccuracies of a stop-watch due to the so-called subjective time of the observer. The new time measurement is based on the counting of the alternative current frequencies of 50 cycles elapsed during the measurement. The new instrument can be connected to 110 or 220 Volts. Two dials indicate the elapsed time in whole seconds and in 1/10 of a second respectively. The accuracy is 0.03—0.05 of a second due to the starting and running-down loss of the small synchronous motor. EF.

Interferometric Methods for Investigation of Steel Balls with Regard to Their Shape and for Examination of the Pressure Equations of Hertz (Interferometrische Methode zur Bestimmung der Gestalt von Stahlkugeln und zur Pruefung der Hertzschen Druckgleichungen). O. Schoenrock and E. Einsporn. Zs. Instrument, July 1929, pp. 318-331 and August 1929, pp. 369-385.

The interferometer of Schoenrock, based on plane-paralled quartz plates between which the balls are placed, is fully described. The discrepancies of diameter and roundness of the balls is measured by means of the interference of light. The influence of the plate-pressure, of temperature and of air-pressure as well as the accuracy of the measurement are discussed, confirmed by numerous tests. The authors conclude with a discussion on the specific gravity of steel balls. EF.

On a New Direction Finder (Ueber einen neuen Richtungshoerer). Chr. von Hofe. Zs. Instrument, July 1929, pp. 331-341.

The new apparatus designed by Drs. Maurer and Hascheck is explained and theoretically discussed. An increased accuracy is obtained by picking up sounds from the left side exclusively with the left ear and vice versa. A sound directly in front is heard by both ears. Since the angular range is very limited, an exact adjustment of direction is obtained. Experiments are outlined with particular consideration of accuracy of adjustment and operation-distance. EF.

Contributions to the Theory of the Magnometer of Tiberg-Thalen (Beitraege zur Theorie des Magnetometers von Tiberg-Thalen). V. Theimer. Zs. Instrument, July 1929, pp. 342-356, August 1929, pp. 386-395.

The theory of the magnometer by means of which the horizontal and vertical intensity of the terrestrial-magnetic field is determined, is critically discussed. After describing the apparatus of Tiberg-Thalen, the author outlines the fundamental principles involved in the construction of the instrument. The application of the Tiberg-Thalen magnometer for the exploration of ore deposits is given. The paper contains 77 formula and their derivation. EF.

The Determination of Temperature and Atmospheric Density Constants of Forge of Gravity Pendula by Means of the Two Pendula Method (Bestimmung der Temperatur und der Luftdichtekonstanten von Schwerkraftpendeln nach dem Zweipendelverfahren). H. Schmehl and W. Jeune. Zs. Instrument, August 1929, pp. 396-406.

The authors prove by means of pendulum observations that the determination of temperature and density constants of gravity-pendula according to the two pendula method has the following advantages in comparison with the one-pendulum method: 1) the time of observation is cut down to one half, 2) the accuracy of determination of the constants is increased, 3) the work for reducing the data is simplified. The compensation of the observations according to coincident times instead of vibration times as well as the compensation of the whole method in one step signify a further considerable advantage. The paper includes 9 references. EF.

(Current Literature Review continued on Page 27)

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(Buyers' Guide continued on Page 28)

Measurement of Flame Temperatures. E. Griffiths and J. H. Awbery. Proc. Roy. Soc., April 1929, pp. 401-421.

The temperature of a platinum wire carrying an electric current is measured by an optical pyrometer when in the flame and when in vacuum. The temperature at which the 2 temperature-current curves intersect is the temperature of the flame since convection losses are then zero in both cases. In a second method the temperature of a Point-o-lite lamp sphere is adjusted until the absorption or emission lines of sodium (which is introduced into the flame for the purpose), produced by the interposition of the flame between the lamp and spectroscope, disappear into the continuous background. The temperature of the Point-o-lite sphere is then that of the flame and may be measured by an optical pyrometer.—Abs. Bull. Kodak Res. Labs.

Photo-Electric Method of Measuring the Light of the Night Sky, with Studies of the Course of Variation Through the Night. Rayleigh. Proc. Roy. Soc., June 4, 1929, pp. 395-408.

An electrometer, with a leak to earth, was used to measure the photo-electric current in preference to valve amplification. The light of the sky was balanced against that from a small incandescent lamp the brightness of which was controlled by a resistance. There is a diurnal variation with a maximum at midnight.—Abs. Bull. Kodak Res. Labs.

Determination of the Dielectric Constants of Imperfect Insulators. R. T. Lattey and O. Gatty. Phil. Mag., June 1929, pp. 985-1004.

Mathematical and practical considerations of methods of measurement of dielectric constant in such a way as to allow elimination of, or correction for, errors through inductance and capacity of the condenser leads, effects of leakages, and certain other factors. The results obtained for various organic liquids are given, and compared with those of other authors.—Abs. Bull. Kodak Res. Labs.

The Conductance and Transference Number of the Chloride Ion in Mixtures of Sodium and Potassium Chlorides. Duncan A. MacInnes, Irving A. Cowperthwaite and Theodore Shedlovsky. Jl. Amer. Chem. Soc., September 1929, pp. 2671-2676.

An addition to the moving boundary apparatus for determining transference numbers is described, with the aid of which the boundary can be formed without disturbing the apparatus while it is mounted on a vibration-free support.—M.E.H.

Industrial Measurements. I-Weighing. Everett P. Partridge. Ind. & Eng. Chem., August 1929, pp. 740-744.

This article treats the weighing problems occurring in manufacturing the products of the process industries. These problems are reduced to (1) weighing the raw materials; (2) compounding and check-weighing; (3) packaging and product measuring. Some typical applications of scales in each of these fields are discussed.—M.E.H.

Effects of Knock-Suppressing and Knock-Inducing Substances on the Ignition and Partial Combustion of Certain Fuels. Raymond E. Schaad and Cecil E. Boord. Ind. & Eng. Chem., August 1929, pp. 756-762.

Presented before the Division of Petroleum Chemistry at the Detroit Meeting of the American Chemical Society, September 1927. Apparatus for hot-wire ignition, break-spark ignition and pre-ignition combustion is described and diagrams are included. A bibliography of 21 references is given.—M.E.H.

Meaning and Measurement of Plasticity. E. Karrer. Ind. & Eng. Chem., August 1929, pp. 770-773.

Presented before the Division of Rubber Chemistry at the Swampscott Meeting of the American Chemical Society, September 1928. The new plastometer is briefly described but no diagram given. The apparatus gives the magnitude of the force acting for a definite time, the amount of the deformation and the portion of this deformation which is retained up to a definite time.—M.E.H.

Vaporization of Complex Mixtures. Walter J. Podbielniak and Geo. Granger Brown. Ind. & Eng. Chem., August 1929, pp. 773-779.

A differential and a continuous or flash vaporizer are described and a diagram of each type is given.—M.E.H.

X-Ray Study of the Zonal Structure of Silica Brick from the Roof of a Basic Open-Hearth Furnace. G. L. Clark and H. V. Anderson. Ind. & Eng. Chem., August 1929, pp. 781-785.

Bibliography of 22 references. X-ray diffraction patterns by the "powder method" have been obtained for pure quartz, ganister, burned silica brick and the various zones of silica brick after the usual service in an open-hearth furnace. The x-ray diffraction method suggests itself as another procedure for the detection of the various forms of silica in silica refractories.—M.E.H.

Inflammability of Mixtures of Ethyl Alcohol, Benzene Furfural, and Acetone. G. W. Jones and J. R. Klick. Ind. & Eng. Chem., August 1929, pp. 791-793.

Presented before the Division of Gas and Fuel Chemistry at the Columbus Meeting of the American Chemical Society, April 1929. The apparatus used for determining the limits of inflammability modified for use at higher temperatures is shown in diagram.—M.E.H.

Rapid-Indicating Continuous-Reading Vacuum and Pressure Gages. H. G. Anderson. Ind. & Eng. Chem., August 1929, pp. 795-797.

Two gages have been developed for measuring pressures continuously and at high speeds. These gages will withstand a change of pressure from atmospheric to zero without injury. Pressure measurements are made almost instantly. Both are of the hot-wire type. Electrical circuits are given.—M.E.H.

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(Buyers' Guide continued on Page 30)

Automatic Oscillographs—Are a Valuable Adjunct to the Synchronized at the Load System in New York City. H. R. Searing and G. R. Milne. Electric Journal, August 1929, pp. 351-357.

The United Electric Light & Power Co. has developed a method of holding individual generators in a synchronism at the load only. System connections, oscillographic equipment, use of records obtained, actuating devices and details of operation are given. Numerous tables, curves and charts are shown for the Hell Gate (N. Y.) automatic oscillograph equipment. W. H. B.

Barberton Laboratory for High-Voltage Tests. Electric World. August 3, 1929, p. 218.

This outdoor laboratory of the Ohio Brass Co. at Barberton, O., appeals to the operating engineer. Potential up to 3,000,000 volts can be applied anywhere on each side of the cage conductor and can be measured by a variety of portable sphere gaps. Records of voltage conditions and discharges can be made on Dufour oscillographs and klydonographs adjacent to the field. A camera synchronized with the test-voltage source permits photographs of discharges in the daylight. W. H. B.

Improved Simple Viscosimeter for Colored Fluids. A. E. Robinson. Ind. Chemist, May, 1929, pp. 205-206.

A modification of the falling ball method, in which the steel ball makes a contact at the end of its fall, closing an electric circuit and causing a small globe to light. The apparatus has been provisionally protected.—Abs. Bull. Kodak Res. Labs.

Apparatus and Method for the Rapid Determination of Available Chlorine in Weak Hypochloride Liquor. J. M. Taylor. Ind. Chemist, April 1929, pp. 135-136.

A rapid method for use in a works where a chemist is not available. The pressure generated by the oxygen evolved on mixing known volumes of the blech liquor and hydrogen peroxide is measured by means of an ordinary pressure gauge.—Abs. Bull. Kodak Res. Labs.

Determination of Available Oxygen by the Bunsen Method. T. W. Parker and P. L. Robinson. Jl. Chem. Soc., May, 1929, pp. 1106-1108.

A description of an apparatus for accurate determination of available oxygen by the Bunsen method, in which chlorine is liberated and estimated iodimetrically. Results quoted for a particular sample of potassium dichromate indicate a concordance of 1 part in 3250 parts, the mean being 0.18% below the theoretical value.—Abs. Bull. Kodak Res. Labs.

Detection, Determination and Oxidation of Sulfur Dioxide. D. Henville. Analyst, April 1929, pp. 228-231.

An apparatus for the rapid execution of the Monier-Williams method, in which the weighed amount of sample is heated in a 500-c.c. flask with 50 c.c. of 16% (by volume) solution of hydrochloric acid and 150 ml. of air-free water. The evolved sulfur dioxide is absorbed in hydrogen peroxide which is titrated with N/10 sodium hydroxide in the presence of bromphenol blue during the course of the heating. It is shown that no appreciable oxidation of sulfur dioxide occurs during the course of the determination.—Abs. Bull. Kodak Res. Labs.

New Apparatus for Electrolytic Analysis. H. J. S. Sand. Analyst, May 1929, pp. 275-282.

Descriptions of new types of platinum electrodes and stands for analysis by electrodeposition, the main object of the design being to attain a reduction in weight of the platinum required and efficient working. One electrode revolves inside the other and is completely surrounded by it except from below. Special features allow rapid washing and disconnection. A modification of the rotating anode is described, for use when contact between the electrolyte to be analyzed and the electrode would cause trouble because of anodic oxidation. For this case, the anode is designed to hold a parchment thimble diaphragm, which revolves with it and holds an auxiliary electrolyte, e.g., of dilute acid or a salt.—Abs. Bull. Kodak Res. Labs.

Potentiometric Titration of Ammonia. E. B. R. Prideaux. Jl. Soc. Chem. Ind., April 19, 1929, pp. 87-88T.

Results in agreement with those obtained when using methyl red as indicator were obtained by the use of the quinone-quinhydrone electrode. The potentiometric method has the advantage that it gives better warning of the approach of the end point. It may be applied to the analysis of dark-colored or turbid solutions.—Abs. Bull. Kodak Res. Labs.

Estimation of Cellulose in Wood. J. H. Ross, A. L. Davidson and E. O. Houghton. Pulp and Paper, June 20, 1929, pp. 925-926.

The Pulp and Paper Division of the Forest Products Laboratory suggests a new method of determining the amount of cellulose in wood. The wood ground to meal is treated with sodium hypochlorite solution, treated with sodium sulfite as an anti-chlor, and finally washed with ammonia water to remove chlorinated products. This cellulose is not pure but is equivalent to the type and amount obtained from wood chlorination with gaseous chlorine. —Abs. Bull. Kodak Res. Labs.

Microscopical Examination of Fibers. W. Garner. Ind. Chemist, April 1929, pp. 147-155.

Although for routine work dilute glycerin is suitable, permanent mounts are best made by means of glycerin jelly. An advantage of this material is that slides are so easily cleaned if the amounts prove to be of only passing interest. By choosing suitable media, certain fibers can be rendered almost invisible; thus in a mixture of acetate silk with rayon, examination is facilitated by mounting in dilute glycerin, which causes the acetate silk to become almost invisible. The differentiation of silk, wild silks, and rayons is dealt with in detail, and the determination of these fibers and of fibers of vegetable and animal origin is illustrated by photomicrographs. The technique of cutting sections of fibers is given.—Abs. Bull. Kodak Res. Labs.

(Current Literature Review continued on Page 31)

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Reuther Indicating and Recording Meters for Hydraulic Plants. J. Burkhardt. Engineering Progress, August 1929, pp. 199-203.

Description of a number of large flow water metering devices manufactured by Bopp & Reuther for every purpose and all conditions of use.—K.F.

The De Juhasz Indicator. Kalman J. De Juhasz. Automobile Engineer, August 1929, pp. 303-307.

Gives history and present status of the De Juhasz indicator which is used for indicating high-speed engines and is suitable for research on all kinds of periodically recurring pressure phenomena. The apparatus which is characterized by the lack of electrical and optical complications is set up on the engine and the pressure diagram is drawn by pencil on paper. Many diagrams and illustrations.—K.F.

Stop-Watches for Engineers. Automobile Engineer, August 1929, p. 294.

Description of Arnold stop watches and the particular uses for which each style is designed.—K.F.

An Apparatus for the Measurement of Magnetic Susceptibility. W. Sucksmith. London, Edinburgh & Dublin Philosophical Magazine & Journal of Science, August 1929, pp. 158-165.

Describes a simple apparatus capable of rapid and fairly accurate measurement of moderate susceptibilities. Gives a theoretical discussion and contains formulas and tables. The method could be easily adapted to measurements of the large forces on paramagnetic substances at very low temperatures.—K.F.

Easy-Reading Mercury Thermometer. Brass World, August 1929, p. 186.

The A. E. Moeller Co., Brooklyn, N. Y. features a red reading column. The bottom of the red column is the top of the mercury column.—W.H.B.

Integrated CO Test Checks Stoker Operation. Irvin G. McChesney Electrical World, August 31, 1929, p. 426.

Gas, taken from the last pass of the boiler, is washed in sulphuric acid, moistened by passing through water, then through a glass flowmeter consisting of a glass tube with a nozzle plate and pitot connections to an inclined manometer. The nozzle diameter of this integrator is 0.033 in. and passes 90 grams of gas per hr. at 72° F. and a head of 2.3 in. of water. The flow meter is calibrated by passing air through a precision gas meter. The gas passes from the flow meter into an iodine pentoxide container and thence to the exit. The liberated iodine is absorbed in potassium iodine wash bottles over a definite period of time and then determined by analysis. From the data the flow of sample in grams per hr., time of operation and free iodine recovered, the average CO content is computed. The equipment is illustrated.—W.H.B.

Armature Tests and Testing Equipment Surveyed. R. S. Beers. Electric Railway Journal, August 1929, p. 798.

A survey of 30 representative railways shows the following tests commonly used when rewinding armatures: (1) bar to bar test of commutator; (2) high-potential test of commutator; (3) position of armature coil leads; (4) high-potential test of coils; (5) short and open-circuited coils; (6) high-potential test of complete armature; and (7) running test. The millivoltmeter test of armatures for open and short circuits is the most successful test available and a constant current is essential. This current is best obtained by use of a 6-volt storage battery, ammeter, and a variable resistance. W. H. B.

Transmission Line Insulation and Field Tests Pertaining to Lightning. W. W. Lewis. G. E. Rev., July 1929, pp. 364-376.

A paper read at the International Conference on Large Electric High-tension Systems, Paris, France. A consideration of results obtained from the study of the peculiarities of lightning and of means of deducting the most effective means to prevent it from interfering with electrical service. The surge voltage recorder, the cathode-ray oscillograph and the lightning laboratory at Wallenpaupeck on the Pennsylvania Power and Light Co.'s system are illustrated and numerous charts, tables and curves are shown. W. H. B.

Tellurium Thermo-Couples (Tellur Thermoelements). B. Lange and W. Heller. Physikalische Zeitschrift, July 1, 1929, pp. 419-425.

Tellurium-platinum thermo-couples have been constructed which, in a suitably applicable form, exhibited quite exact measurements of temperature between —75° and —90°C. The thermal force within this range proved to be almost completely constant. The great thermal power of these thermo-couples amounting to 400 x 10^{-6} volts/ degree permitted the use of less sensitive galvanometers as a zero instrument with an accuracy of 1/10 degree. It was determined that the thermal power of Tellurium up to 400°C is a straight line function between 0° and 40°C. A temperature coefficient of 0.00325 was ascertained between 20° and 40° which due to its constancy within this range, suggests the applicability of Tellurium as resistance thermometer material. Experiences with thermo-couples composed of Te and Cu did not yield favorable results. H. A.

Determination of the Softening Point of a Pitch or Bitumen. G. M. Green. Jl. Soc. Chem. Ind., May 17, 1929, p. 114T.

This original method, which gives results with a reproducibility of 1°C., and within a degree or two of the Kraemar and Sarnow method, consists in impaling a spherical piece of the sample under test on the spear-shaped point of a drawing pin. This is dropped into a large size boiling tube fitted with a thermometer and stirrer, and containing a solution of potassium iodide saturated at 16°C. The temperature is very slowly raised, and, at the softening point, the small sphere of sample "tails off" and floats to the surface of the solution. Abs. Bull. Kodak Res. Labs.

(Current Literature Review continued on Page 33)

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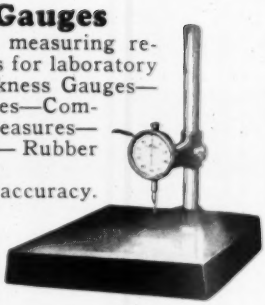

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When writing to the above companies, mention INSTRUMENTS

Estimation of Hydrogen in Steel. J. E. Rooney and Guy Barr. Fuels and Furnaces, July 1929, p. 1078.

Abstract of paper before Iron and Steel Institute. Method consists of heating sample in known volume of nitrogen and measuring the volume of hydrogen evolved by means of the Shakespear authorometer.—M.S.

Early Developments of Orifice Meter Measurements. Thomas R. Weymouth. Gas Service Journal, July 1929, pp. 8-10.

Brief history of Pitot tube, and of pioneer orifice instruments accurate within 2%.—Mc

Developments in Regulation and Control of Industrial Furnaces. J. W. Jones. Fuels and Furnaces, July 1929, pp. 1057-1058.

Abstract of paper before the Association of Iron and Steel Electrical Engineers, June 17-21, 1929. Summarizes refinements made in carbon dioxide and steam flow meters, control pyrometers, open hearth furnace control, controls for heating furnaces, magnetic type valve, gas analysis apparatus, etc.—M.S.

Foundry Coke Specifications. J. E. Urquhart. Fuels and Furnaces, July 1929, pp. 1071-1072.

Abstract of paper before joint Production and Chemical Conference of the American Gas Association, May 27-29, 1929. Discusses the formulation of specifications as related to the establishment of various tests.—M.S.

Progress in the Testing of Refractories. Fuels and Furnaces, July 1929, pp. 1077-1078.

Abstract of report of Committee on Refractories of the American Society for Testing Materials, June 24-28, 1929. Recommends revision of the heating rate of the standard method of test for softening point of fire clay brick. Deals also with service spalling test, the reheating test, and abrasion test for silica brick.—M.S.

An X-Ray Study of Firebrick. Albert E. R. Westman. Bulletin No. 193, Engineering Experiment Station, University of Illinois.

This bulletin shows powder diffraction patterns of a number of commercial firebricks, to find what information could be obtained from the patterns, and to compare the information so obtained with that secured by thermal expansion measurements, petrographic examinations, and chemical analyses.

Design of a Double X-Ray Spectrometer. J. H. Williams and S. K. Allison. Jl. Opt. Soc., June 1929, pp. 473-478.

A double x-ray spectrometer built by the authors is described.

Magnetic Testing Furnace for Toroidal Cores. G. A. Kelsall. Jl. Opt. Soc., July 1929, pp. 47-49.

Furnace is briefly described.

An Improved Constant Current Regulator. L. Longsworth and D. MacInnes. Jl. Opt. Soc., July 1929, pp. 49-56.

An apparatus is described for automatically maintaining a constant current through a circuit in which gradual increases and decreases of resistance and e.m.f. are occurring.

Some Practical Methods of Measuring Gauge at the Calenders. E. Dieterich. Rubber Age, July 10, 1929, pp. 375-377.

The instruments considered are: hand gauges, mechanical weighing devices, the radio gauge and the magnetic gauge.

A New Measuring Microscope and Its Application as a Reading Arrangement as Well as a Measuring Instrument. Dr. Hohenner. Zeits. Vermessungswesen, May 15, 1929, pp. 353-366.

The instrument is described in considerable detail.

A New Thermopile for the Measurement of Nerve Heat Production. A. C. Dawning and A. V. Hill. Proc. Royal Society, July 4, 1929, Series B, pp. 147-152.

A new type of thermopile is described, for the measurement of heat production in stimulated nerve, which has the following advantages as compared with previous instruments: (a) it gives twice the e.m.f. per 1° C.; (b) it loses heat appreciably less rapidly; (c) it "settles down" in about 1/3 the time, and has a more constant "zero;" it is easy to construct.

A Piston Leak Gage for Pneumatic Hammers. P. J. McCullough. American Machinist, September 12, 1929, pp. 451-452.

Describes with the aid of a diagram, the operation of a gage for testing leakage in pneumatic hammers.—K.F.

Indexing Head for Highly Accurate Spacing. Freeman C. Duston. Machinery, September 1929, pp. 14-16.

Describes in detail the construction and use of the precision indexing head developed by Bell Telephone Laboratories and employed in making the accurate gears and perforated disks required for television equipment.—K.F.

Instrument Indicates Temperature of Airplane Engines. Machinery, September 1929, p. 60.

Brief notice of an indicator developed by General Electric Co.—K.F.

INDEX CARD SECTION

A file card index will be a valuable asset. It is suggested that this index information be cut out, mounted on cards, and filed in your desk or in a file box on top of your desk. You will then have within easy reach an index of instrument information of incalculable value.

THE INSTRUMENT EXHIBITS AT THE NATIONAL METAL EXPOSITION
INSTRUMENTS, Vol. 2, No. 10, October 1929, pp. 333-336, 4 figs.
The instrument exhibits are briefly described.

MEASUREMENTS—INDUSTRIAL AND SCIENTIFIC
DR. WALTER BLOCK, INSTRUMENTS, Vol. 2, No. 10, October 1929, pp. 337-346.
This is the second installment of a series. The original work is a German book entitled "Messen und Waegen." This installment considers the historical development of the measuring science and the systems of length and weight in Prussia, France, England and the United States.

THE MEASUREMENT OF AIR FLOW
E. OWER, INSTRUMENTS, Vol. 2, No. 10, October 1929, pp. 347-358, 2 figs.
This is the first installment of a series on the measurement of air flow. It briefly introduces the subjects and then covers the general principles of the pressure-tube anemometer.

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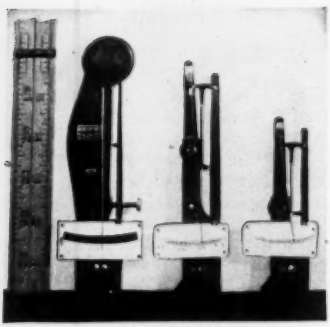

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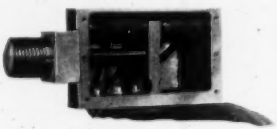

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